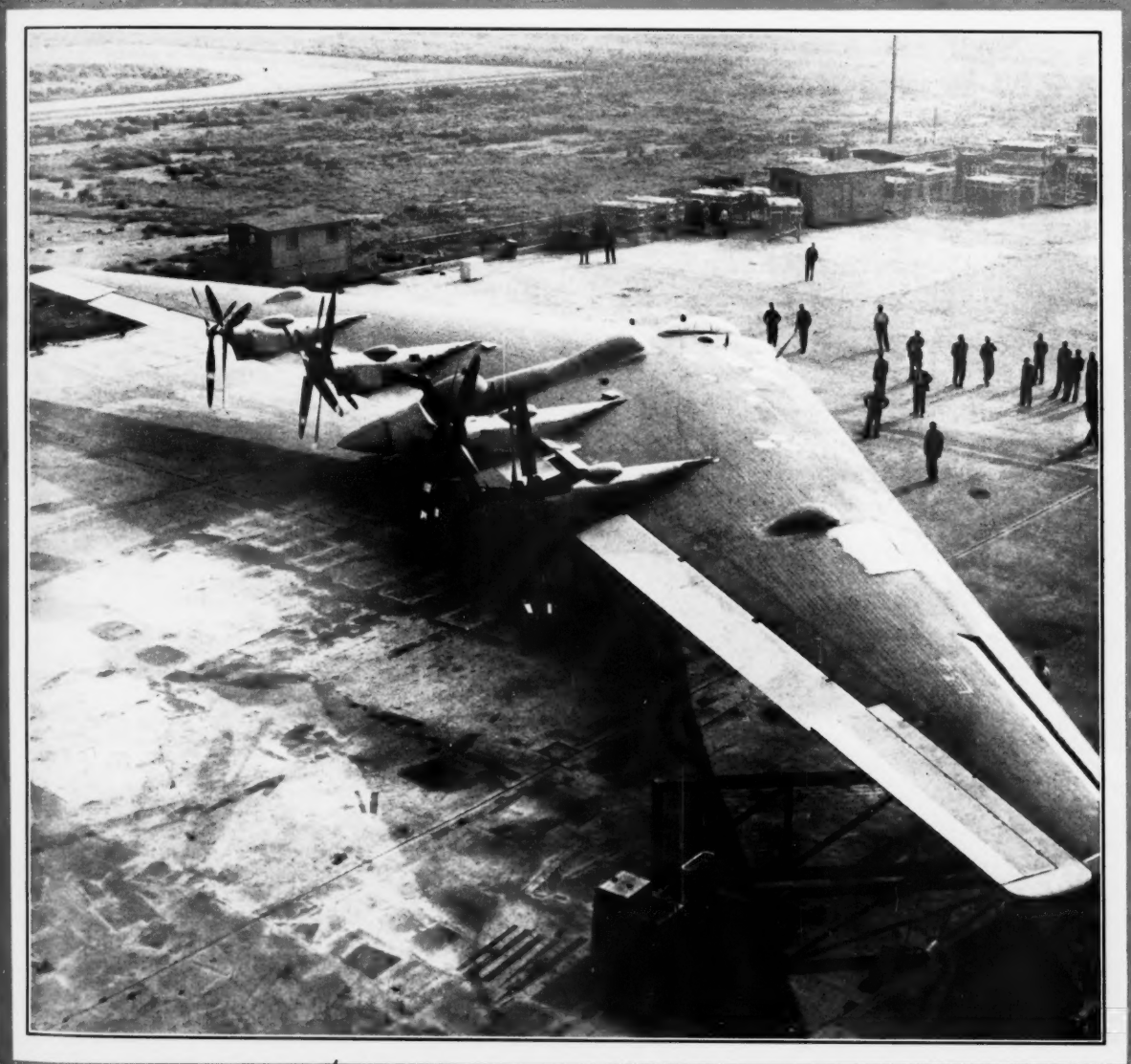
AERONAUTICAL ENGINEERING REVIEW

JUNE 1946



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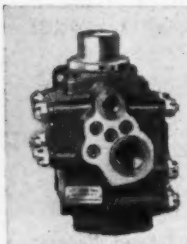

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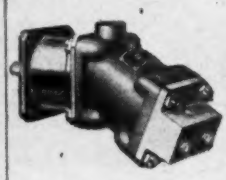

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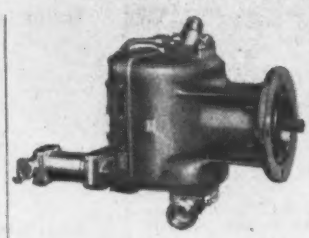

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Precision Autosyns for Servo Systems

J. P. GLASS* and P. F. BECHBERGER†

Bendix Aviation Corporation

ABSTRACT

A group of small synchros called "Precision Autosyns" are now being manufactured in three basic types: transmitter or receiver, differential, and sine-cosine generator or resolver. All units are the same size, weighing 5 oz., and operate from 26 volts 400 cycles. Maximum system error spreads of approximately 1/2° are maintained and can be reduced to 1/4° spread by the matching of units.

INTRODUCTION

IN 1934 ECLIPSE-PIONEER began building lightweight aircraft Autosyns, or synchros, weighing 10 oz. and operating from 32 volts 60 cycles (Fig. 1), thereby providing a solution for remote engine instrumentation. These original aircraft Autosyns solved the perplexing problem of remote engine instrumentation in the four-engined bomber. In order to reduce weight and power consumption, the miniature Autosyn was designed weighing only 5 oz. and operating on 26 volts at 400 cycles. Production on these began in 1940. The maximum expected error of an indicating system composed of two of these miniature Autosyns, one as transmitter and one as indicator carrying a pointer or dial, is 1 1/2°. This accuracy is adequate for most remote indicating requirements, since the error is less than 1/2 per cent of available full scale. Another use of Autosyns is in remote power positioning controls, known as servos, and many servo applications kept arising where a higher order of accuracy was not only desirable and usable but in some cases necessary.

By late in 1943 Eclipse-Pioneer, either in its own plants or in the plants of subcontractors, had produced several million units of various types. At that time all the engineers at Eclipse-Pioneer who had been in any way connected with the development, design, and production of Autosyns were called together for a round-table discussion to pool their experience. Needless to say, the conference brought out many suggested changes and improvements.

DESIGN CHANGES

Primarily as a result of this conference, changes were incorporated in a new design, the "Precision Autosyn." These changes could be grouped as follows: (a) mechanical design refinements, (b) electric and magnetic structure improvements, (c) tooling and machining advances, and (d) improved test equipment.

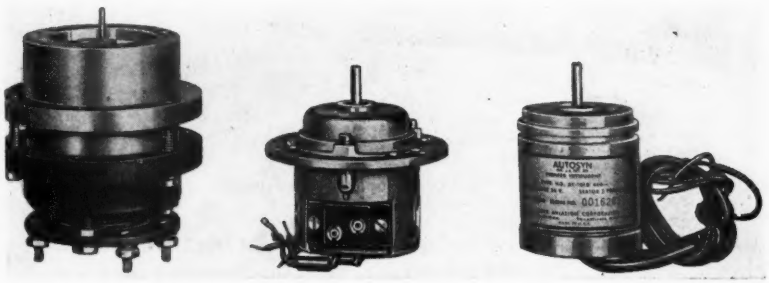

Fig. 1. Successive stages of Autosyn design. (a) Original. (b) Miniature. (c) Precision.

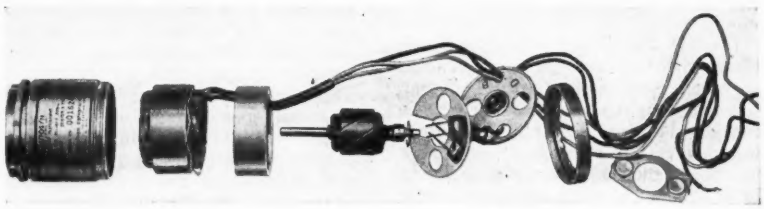

Fig. 2. Disassembled parts of Precision Autosyn.

Mechanical Design Refinements (Fig. 2)

The housing for the Precision Autosyn has been so designed that clamping it, both during machining and in use, will not distort it or cause error. Its important diameters requiring close concentricity—namely, front bearing diameter, stator diameter, and locating diameter for rear housing plate—can all be machined together. Likewise, the design is such that the inevitable nicks developed during handling of parts will have a minimum of effect. The method of mounting allows easy angular adjustment in its associated equipment, and the housing can be provided with four tapped holes in the front to carry a gear or sector to allow convenient local angular control. The back of the housing is threaded, which, with a convenient lock, provides a fast means of end-play adjustment, heretofore a tedious shimming operation.

The stator laminations are cemented together, providing a stator lamination assembly that is as rigid as one piece of metal and thus can be machined and ground to close tolerances. The brushes are so arranged that they need not be removed when taking out the rotor, and, when the rotor is replaced, a mere spin of the rotor snaps them back into their proper place. In fact, the Precision Autosyn can be completely disassembled and reassembled in a few seconds with no tools whatever.

The ball bearings are lubricated with an oil that protects them against rust and is suitable over a wide temperature range. The stator and rotor laminations are coated with an improved finish that gives them much better protection to rusting than has been possible in the past. The ruggedness of the design has been proved by its ability to withstand vibration and shock tests.

Electric and Magnetic Structure Improvements

By skewing the rotor instead of the stator, small axial position changes of rotor with respect to stator do not show as angular changes. Proper amount of skew of the rotor is important, and the turn placement in slots giving correct winding symmetry has been determined to produce minimum error. By using a cylindrical rotor that is magnetically independent of angle, several servos can be operated in parallel from one source, and, if one should be turned off or fail for any reason, the others would continue to operate with unreduced accuracy.

Choice of operating voltage has contributed materially. Four-hundred-cycle power is supplied at 26 volts, corresponding to standard aircraft instrument practice, and secondary circuits operate at 11.8 volts maximum. Small

Received October 3, 1945.

* Philadelphia Division.

† Eclipse-Pioneer Division.

Fig. 3. Calibrator for Precision Autosyn.

Autosyns wound for these voltages have impedances of the same order as the characteristic line impedance of aircraft wiring. This means that the normal differences of resistance and capacity of the interconnecting leads will have a minimum effect on accuracy.

If a 115-volt supply voltage had been chosen, insulation would have occupied so much more space that the overall size and weight would have had to be considerably increased and the windings would have had an impractically large number of turns of a wire size so fine as to be difficult to wind and constitute a source of failure.

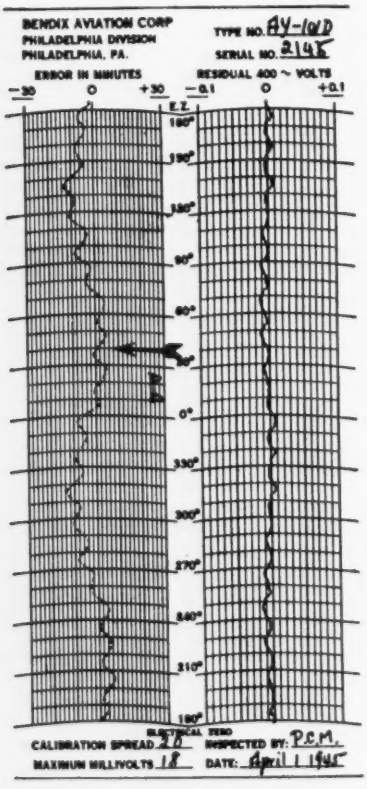

Fig. 4. Calibration chart for Precision Autosyn.

Tooling and Machining Advances

It is one thing to have the engineer decide he would like to have certain dimensions held to one or two ten-thousandths of an inch and altogether another thing to convince production that such close tolerances are necessary and actually maintain them on piece after piece with a minimum of rejects. Because of improved test equipment, which will be described later, and because of special gages easily read to "half a tenth" (0.00005 in.), it has been possible to determine just what effect each dimensional tolerance contributes to the final overall error. For example, stator bore out of roundness causes 4′ of error spread per 0.0001 in. Such information greatly simplifies the problems of deciding what tolerances must be held and of convincing production personnel that it is necessary. More is required, however, than the desire of production personnel to hold close tolerances. Tooling has had to be revised many times to hold some dimensions properly, and the whole sequence of machining operations on each part must be worked out "just so" to attain consistently good results. Deep interest, enthusiasm, and even devotion to the job by "heads-up" tool and production people are a prime necessity.

Improved Test Equipment

Various forms of automatic calibration machines have been used in the past, but the accuracy being built into the Precision Autosyn required a calibrator of a higher order of performance. The machine shown in Fig. 3 uses a "master" Autosyn as a transmitter connected to the Precision Autosyn under test as the receiver in a servo system. The low null voltages appearing across the rotor under test make possible the use of sensitive amplifiers, so sensitive, in fact, that the servomotors of the calibrator respond to deflections of less than $\frac{1}{2}'$ of angle. These machines are used in production tests, and each Autosyn is supplied with a machine-drawn calibration chart, similar to that shown in Fig. 4. On the chart the curve to the right shows the out-of-phase voltage at null. So accurately does the machine repeat a calibration that it is possible to change the color of ink before a rerun and completely cover the first curve so that none of its color shows.

Since all Autosyn calibration tests consist of comparing the unit under test with a master, it becomes important to have accurate masters. Methods have been worked out and are so refined that it is now possible to standardize the masters to an absolute accuracy of about 1′. This represents the limit of reliable results with present designs and equipment, because such things as light radial loads on the Autosyn shafts, slight motions of the axis of the rotor due to the rolling back and forth, etc., cause errors of several minutes unless precautions are taken. Thus the shaft that joins the masters and the Autosyns under test has been lightened and equipped with flexible joints. Since slight misalignment of the axis and any dial used for calibration will produce apparent errors greatly in excess of those

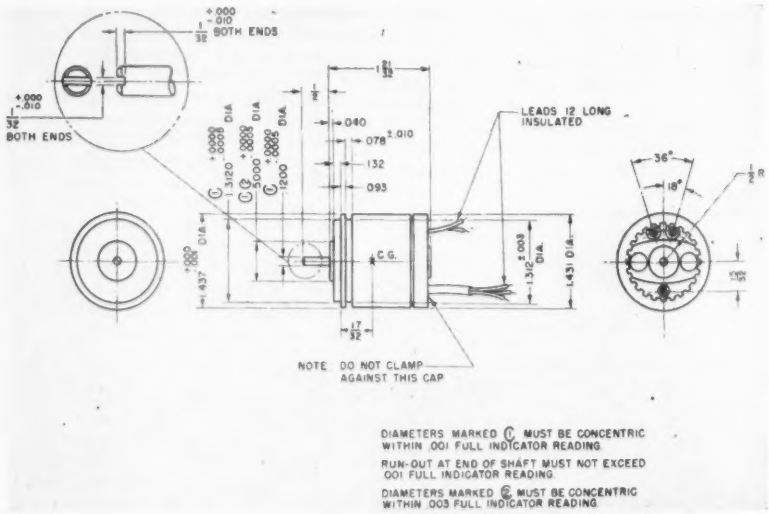
BOTH ENDS
LEADS 12 LONG INSULATED
C.G.
NOTE DO NOT CLAMP AGAINST THIS CAP
DIAMETERS MARKED C MUST BE CONCENTRIC WITHIN .001 FULL INDICATOR READING.
RUN-OUT AT END OF SHAFT MUST NOT EXCEED .001 FULL INDICATOR READING.
DIAMETERS MARKED C MUST BE CONCENTRIC WITHIN .003 FULL INDICATOR READING.

Fig. 5. Dimensional drawing of Precision Autosyn.

in the Precision Autosyns, it is almost impossible to calibrate them accurately without the automatic machine. Some equipment has been successful using accurate, transit-type dials mounted on the shaft and read against a stationary vernier.

The errors are expressed in "spreads" because that is the easiest way to measure them accurately and because the users of the Precision Autosyns are more interested in the maximum error than in the mean error or the probable error. In order to get a comparative picture of the meaning of these different methods of designating the error refer to Fig. 4. The error spread is 20′. The maximum absolute error shown is 14′, but this is dependent on the zero setting and is not as fundamental as the spread. The mean error from the mean datum is only 4.2′; from the chart zero, the mean error is less than 5′. But to measure these accurately means a planimeter is required and the operation is a slow one.

Transmitter and Receiver

The individual types conform in general to the outline in Fig. 5. The Autosyn Transmitter (Synchro Generator) is a unit, the rotor (primary) of which is mechanically driven, for generating and transmitting electrical information corresponding to angular positions of the rotor.

The Autosyn Receiver (Synchro Control Transformer) is a unit, the rotor (secondary) of which is mechanically driven until the voltage induced in the rotor from its stator (primary) becomes null and the final angular position corresponds to that set up by the transmitter.

The most typical unit designed for use as a servo transmitter or receiver is the AY-101D.

This Autosyn consists of a cylindrical single-phase distributed wound rotor for operation at 26 volts 400 cycles and a Y-connected three-phase stator, so wound that the coupling factors are sines of the rotor angle.

The voltages induced in the rotor of the receiver are generally impressed upon grids of thermionic tubes or similar devices used for the control of servo units.

This unit is not intended for use as an indicator (synchro motor) operating on its own torque.

The design of these Autosyns features high accuracy for servo positioning—a maximum of 0.4° spread against a master for each unit. Production figures indicate that the accuracy values are between 10′ to 20′ spread against the master.

For electrical, mechanical, and circuit characteristics of AY-101D as a transmitter to a single AY-101D as a receiver see Table 1.

The accuracy indicated is based on the theoretical maximum spread computed by adding the maximum possible error in each component. This procedure is mathematically correct, but, as the various errors are actually vectors, the possibility that all vectors at any given time will be in phase with a definite shaft position of all Autosyns is remote. The following empirical relationship can be used to compute the maximum error of a system.

$$0.2n + 0.2 = \text{maximum error}$$

where n is the number of three-phase elements in the system (one for AY-101D; two for AY-131D).

The average spread of pairs of AY-101D Autosyns selected at random and connected as shown in Fig. 6 is less than 0.5°, and by proper interconnection of stator leads this error will not exceed 0.4°. By matching units the spread may be reduced to 0.25°. Nulls normally encountered are between 10 and 20 millivolts.

When two type AY-101D Autosyns are connected as shown in Fig. 6, with all like-colored leads of the stators joined, a clockwise rotation of transmitter shaft will give a clockwise rotation of receiver shaft. To reverse the direction of rotation of either unit simply reverse any two of the stator leads. In order to standardize systems, it is recommended, when a reversal of

Table 1

Electrical Characteristics

Input voltage	Normal excitation	26 volts, single-phase 400 cycles
	Maximum	40 volts, single-phase 400 cycles
Input Current	Normal at 26 volts	65 milliamp., average
	Maximum at 26 volts	75 milliamp., average
Input Power	Normal at 26 volts	0.36 watt
	Maximum at 26 volts	0.50 watt
Rotor resistance (d.c.)		41 ± 10% ohms
Brush contact resistance		1.0 ohm, maximum at 60 r.p.m.
Stator output voltages (line to line)		11.8 ± 0.5 volt, maximum
Stator resistance (d.c.)		10.8 ± 10% ohms

Mechanical Characteristics

Operating temperature range	−65° to +95°C.
Temperature rise	1° except as a transmitter, then 3°C.
Friction at 25°C.	3 Gm. cm., maximum
Friction at −55°C.	6 Gm. cm., maximum
Shaft end play	0 at light load
	0.002 maximum at 3-lb. load
Shaft radial play	0.001 maximum at housing
Radial shaft loading	Under 10 Gm. preferred; 100 Gm., maximum
Weight	5 oz., maximum
Leads	12 in.

Circuit Characteristics (See Fig. 6)

Input		Output	
Current	= 100 milliamp.	Impedance	= 87 + j246 ohms, approximate
Power	= 0.9 watt	Voltage at null	= 0.050 volt, maximum
		Sensitivity	= 0.275 volt/degree
		Accuracy	= 0.8° maximum theoretical spread at receiver

Table 2

Circuit Characteristics (See Fig. 7)

Input		Output	
Current	= 130 milliamp.	Impedance	= 84 + j194 ohms, approximate
Power	= 1.30 watts	Voltage at null	= 50 millivolts, maximum
		Sensitivity	= 215 millivolts/degree
		Accuracy	= 0.8° maximum theoretical spread + small interaction

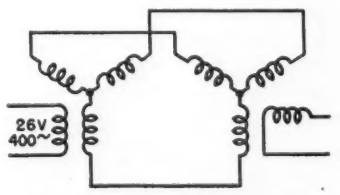

Fig. 6. AY-101D as a transmitter to a single AY-101D as a receiver.

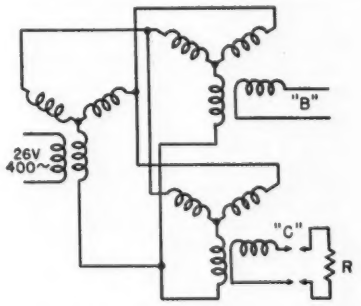

Fig. 7. AY-101D as a transmitter to two AY-101D as receivers in parallel.

direction is required, that the yellow and blue leads be reversed. Also, if it is desirable to have a grounded supply, the black leads should be the ones chosen for grounding.

The circuit characteristics of AY-101D as a transmitter to two AY-101D as receivers in parallel are shown in Table 2.

The comments following Fig. 6, pertaining to the determination of accuracy, apply to Fig. 7 when allowance is made for interaction.

The effect of various resistive loads applied to Autosyn "C" will cause the following interaction error on Autosyn "B." The interaction of Autosyn "C" on Autosyn "B" will be maximum when Autosyn "C" is displaced 45° from the system, and its magnitude under various loads is indicated in Table 3.

TABLE 3

Load on Autosyn "C," Ohms	Interaction Effect on Autosyn "B," Degrees
∞	0.1 or less
5,000	1/2
1,000	2 1/2

DIFFERENTIAL PRECISION AUTOSYNS

The AY-131D is typical of Differential Precision Autosyns. The Autosyn Differential (Synchro Differential Generator), is a unit, the rotor of which is mechanically driven to a desired angle for modifying received electrical angular information and transmit electrical information corresponding to the sum or difference of the respective angles.

The AY-131D has been designed as a differential for use with the AY-101D type of Autosyn. It consists of a cylindrical Y-connected three-phase rotor and a Y-connected three-phase stator identical to the stator used in the AY-101D.

When connected between two AY-101D-type Autosyns, the differential permits the introduction of an additional variable into the receiver unit or units. The angle introduced may add to, or subtract from, the angle introduced by the transmitter, depending on the wiring. The voltage ratio of the differential is 1:1 and the stator and rotor are very nearly matched in impedance. Therefore, the direction of power flow through the unit will have negligible effect. However, the direction for optimum performance will be with the stator used as primary and the rotor as secondary. The design is such that only slight errors will result in the system by interchanging the rotor and stator. During final inspection calibration charts are made on each unit. A sample calibration chart is shown in Fig. 8.

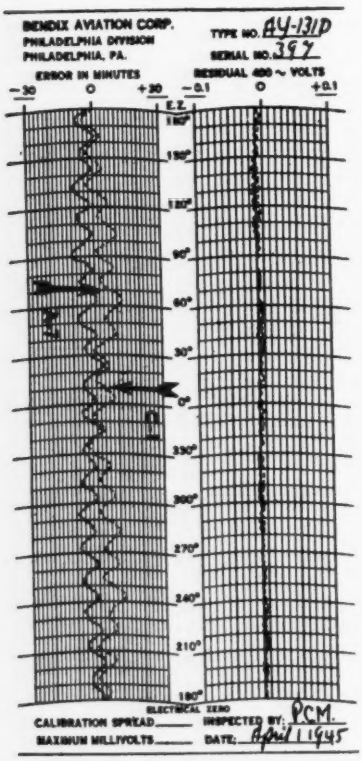

Fig. 8 Calibration Chart for Differential Precision Autosyn.

By connecting all like-colored leads, the differential angle will be the sum of the angles of the transmitter and receiver Autosyns. By interchanging two of the leads connecting the differential with the transmitter, the differential angle will be the difference of the transmitter and receiver angles. To reverse the direction of the receiver only, reverse any two leads connecting the differential to the receiver.

A single differential system permits the introduction of two variables into the receiving circuit. Two differentials permit three variables. The sensitivity of the system decreases with the number of differentials added as shown in the tables of circuit characteristics. For the electrical, mechanical, and circuit characteristics of AY-101D as a transmitter through an AY-131D to an AY-101D as a receiver, see Table 4.

Table 5 gives the circuit characteristics of the double differential system.

RESOLVERS

The AY-123D is typical of resolvers or sine-cosine generator Precision Autosyns. The Autosyn Resolver (Sine-Cosine Generator), is a unit, the rotor of which is mechanically driven to

TABLE 4

Electrical Characteristics

Excitation—Output voltage from AY-101D stator or from another AY-131D

Accuracy { Rotor maximum spread 0.4° / Stator maximum spread 0.4°

Rotor Resistance (d.c.)—11.3 ± 10% ohms

Brush Contact Resistance—1/4 ohm maximum at 60 r.p.m.

Stator Resistance—10.8 ± 10% ohms

Mechanical Characteristics

Operating temperature range	−65° to + 95°C.
Friction at 25°C.	8 Gm. cm., maximum
Friction at −55°C.	16 Gm. cm., maximum
Shaft end play	0 at light load 0.002 maximum at 3-lb. load
Shaft radial play	0.001 maximum at housing
Radial shaft loading	Under 10 Gm. preferred; 100 Gm. maximum
Weight	5 oz., maximum
Leads	12 in.

Circuit Characteristics (See Fig. 9)

Input		Output	
Current	= 115 milliamp.	Impedance	= 94 + j210 ohms
Power	= 1.2 watts	Output voltage at null	= 50 millivolts
		Sensitivity	= 150 millivolts/degree
		Accuracy*	= 1.6° maximum theoretical spread

*The accuracy error is based on the theoretical maximum spread computed by adding the maximum possible error in each component. Using the empirical relationship given for the AY-101D, the maximum error spread becomes 1.0°.

TABLE 5

Double Differential System*

Transmitter AY-101D	Differential AY-131D	Differential AY-131D	Receiver AY-101D
Input		Output	
26 volts 400 cycles	Impedance	= 97 + j200 ohms	
Current = 120 milliamp.	Output voltage at null	= 40 millivolts, maximum	
Power = 1.35 watts	Sensitivity	= 80 millivolts/degree	
	Accuracy	= 2.4° maximum theoretical spread	

* Using the empirical relationship given for the AY-101D, the maximum error spread becomes 1.6°.

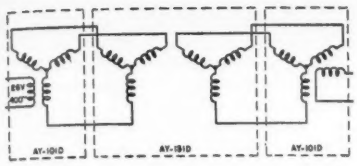

Fig. 9. AY-101D as a transmitter through an AY-131D to an AY-101D as a receiver.

translate: (1) rotor angle into electrical information corresponding to the sine and cosine of rotor angle and (2) electrical information corresponding to the sine-cosine of the rotor angle into rotor angle and the root mean square of their value.

The AY-123D Autosyn provides a convenient method for interchanging rectangular and polar coordinates. This Autosyn consists of a wound symmetrical two-phase rotor and two-phase stator. For general application the unit will receive two single-phase voltages on the rotor, which is mechanically driven to a position corresponding to a null in one of the stator windings. A voltage that is proportional to the root mean square value of the two primary voltages will be induced on the other stator winding.

The AY-123D resolver has been designed for use with the other types of Precision Autosyns or independently. The stator phases are wound for 11.8 volts to match the single phases of the Y-connected stator of the AY-101- and AY-131-type Autosyns. Thus the resultant field in the AY-123 may be made to depend on the position of two other Autosyns. The rotor is wound for 26 volts 400 cycles so that either phase may be excited from the 26-volt line; then the two stator phases have outputs proportional to the sine and cosine of the rotor angle. See Table 6 for the electrical and mechanical characteristics.

TABLE 6

Average Electrical Characteristics

	Rotor	Stator
Input voltage—normal excitation	26	11.8 volts
Input voltage—maximum excitation	40	18.2 volts
Input current	65	110 milliamp.
Input power	0.43	0.32 watt
Phase resistance (d.c.)	46	12 ohms
Brush contact resistance	1.0	. . . ohm maximum at 60 r.p.m.
Output voltages (line to line)	19.2	11.8 volts
Phase impedance	90 + j380	32 + j130 ohms, approximate
Voltage phase shift	6°	3°
Accuracy—spread	20′	20′

Mechanical Characteristics

Operating temperature range	−65° to + 95°C.
Temperature rise	3°C.
Friction at 25°C.	4 Gm. cm., maximum
Friction at −55°C.	8 Gm. cm., maximum
Shaft end play	0 light loads
	0.002 maximum at 3-lb. load

TABLE 7—MATCHING INFORMATION

Forward Rotation:	Code letters and numbers identical.
Reverse Rotation:	Code letters identical. Code numbers total 0 or 18.
Blue substitution:	Add 6 to or subtract 12 from receiver code numbers.
Yellow substitution:	Adds 12 to, or subtracts 6 from, receiver code numbers.

Normal	Blue Substitution	Yellow Substitution
S_2 black lead	S_2 blue lead	S_2 yellow lead
S_3 blue lead	S_3 yellow lead	S_3 black lead
S_1 yellow lead	S_1 black lead	S_1 blue lead

Mismatching by one point, will cause only a small increase in spread over a perfect match.

REDUCTION OF ERRORS IN AUTOSYN SYSTEMS BY MATCHING UNITS

Precision Autosyns are made to a guaranteed maximum error spread of 0.4° in the individual units. When two or more units are connected together in a system, these errors may add or subtract. By matching the Autosyns so that the errors are of the same magnitude but subtractive in phase, the errors of the system can always be made smaller than the errors of the Autosyns composing the system. The combined error spread of unmatched units will almost never exceed 36′; however, by proper matching, error spreads from 10′ to 15′ may be readily obtained.

The chart furnished with each Autosyn shows the error inherent in that Autosyn, and it is the same whether the Autosyn is used as transmitter (generator) or receiver (control transformer) and has little effect on other Autosyns in the system. The ripple in the error curve is not additive but is approximately the same in any system, amounting to 6′ to 8′, and no attempt is made to compensate it. This ripple will largely disappear if the receiver Autosyn is connected to a low impedance load; this cannot be done if paralleled receivers are to be operative with one having stopped.

It is impractical to match Autosyns so that all errors cancel at all points, but the largest single error due to necessary manufacturing tolerances, the second harmonic (so called because there are two cycles of error per revolution), can be reduced to a low value by matching. The Autosyns are coded for magnitude and phase angle of this error. The magnitude of the error is divided into three classifications: A, B, and C, C being the smallest. The phase of the error is divided into 18 steps of 10° each, numbered from 0 to 17. Thus C-13 is a relatively small error having a positive peak at 130° on the chart. This code is stamped on the Autosyn and its chart.

If the transmitter and receivers rotate in the same sense (both clockwise together or counterclockwise together), the errors will be perfectly subtractive when all the Autosyns have the same code (identical calibration). If one or more of the receivers rotate in a sense opposite that of the transmitter (counterclockwise when the transmitter moves clockwise), the sum of the numerical parts of the code should total 0 or 18. Thus, with transmitter code B-16, use reversed receivers coded B-2, but, if there are also parallel forward receivers (operating in the same sense as the transmitter), the forward receiver should be coded B-16.

When the selection of Autosyns must be made from a limited supply, it is possible to reduce the errors greatly by making suitable exchanges in the stator leads of the Autosyns. Normal connection for the Autosyn is with S_2 the black lead, S_3 the blue lead, and S_1 the yellow lead. If the leads are retagged with S_2 the blue lead, S_3 the yellow lead, and S_1 the black lead, a "Blue Substitution" has been made. This substitution will move the synchronous position of the Autosyn rotor 120° and electrical zero must be reset in the usual way, remembering to connect the leads according to the tags. The "Blue Substitution" changes the error code by adding 6 or subtracting 12, thus making it possible to match a B-5 receiver to a B-11 transmitter by making the substitution in the receiver. In a "Yellow Substitution," S_2 is the yellow lead, S_3 is the black lead, and S_1 is the blue lead. The "Yellow Substitution" subtracts 6 or adds 12 to the code. To avoid confusion, substitutions should be made in receivers only (see Table 7).

An application of the code is as follows: A system consists of a transmitter and two parallel receivers, one of which is reversed. The code of the Autosyn being used as a transmitter is A-10, and one of the Autosyns available for receivers is coded A-2. For a reverse rotation system an A-8 Autosyn will be required. By making a "Blue Substitution" in the A-2 receiver, we add 6 making it an A-8 receiver; this Autosyn, when so operated

as a reversed receiver from that transmitter, will have an error spread of less than 15′, whereas, if the "Blue Substitution" were not made, the error spread would be nearly 35′.

Suppose there are no Autosyns available for receivers coded A-10, A-16, or A-4 which are needed for best matching. In such a case it is impossible to find a perfect match for the forward receivers. However, one of the Autosyns is coded A-15; then, by making a yellow substitution in this Autosyn, its new code will be A-9 and it will be mismatched by only one number in the phase code. It will very nearly neutralize the error of the transmitter, and its error spread should be about 15′, whereas, if it is connected without the phase substitution, its error spread will be near 35′.

Suppose that one of the available receivers is coded C-10. This receiver, though it has small error and is phased to match perfectly with the transmitter, will probably show as much error as would the above combination. Although its error is subtractive, it is not large enough to neutralize the error of the transmitter.

In good matches, particularly if the matched Autosyns have small initial error, a system error spread of less than 12′ may be readily obtained.

The charts furnished with precision differentials show two curves; the one in red is the rotor calibration; the one in purple is the stator calibration. There are likewise two error codes: the one on top is for the stator and the one below is for the rotor. Connect the stator to its transmitter just as any receiver stator would be connected and then connect the rotor of the differential, just as though it were the transmitter stator, to the receiver.

This method of matching is particularly worth while where best performance is desired in the differential systems. If random assemblies are made, the poorest combinations produce error spreads up to about 1° whereas if careful matching is carried out, the overall spread can be held to about 20′.

I.A.S. National Meeting Schedule

Annual Summer Meeting

July 18–19, 1946

Los Angeles, California — Royce Hall, University of California at Los Angeles

Air Transport Meeting

October 24, 1946

Washington, D.C. — Hotel Statler

Tenth Wright Brothers Lecture

December 17, 1946

New York, New York — (Location to be announced)

Fifteenth Annual Meeting

January 28–29–30, 1947

New York, New York — (Location to be announced)

The Meetings Committee of the Institute invites participation in the technical sessions of the Air Transport and Fifteenth Annual meetings of the Institute. The program of the Annual Summer Meeting is in process of completion and additional papers cannot be considered.

Members or organizations wishing to submit papers for these meetings should send complete papers, or outlines or summaries, to the Meetings Committee at least three months prior to the meeting at which it is proposed to present the paper. Outlines or summaries should not exceed 1,000 words.

All papers submitted will be considered for publication in the *Journal of the Aeronautical Sciences* or the *Aeronautical Engineering Review*.

All correspondence should be addressed to

The Meetings Committee

Institute of the Aeronautical Sciences

2 East 64th Street

New York 21, N. Y.

Crash Research from the Point of View of Cabin Design*

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Introduction

Safety is the business of forestalling known dangers. The constant effort to reduce danger plays a bigger part in aviation than in other industries not only because dangers in aviation are greater but because they affect public welfare and directly retard aviation's expansion. Accidents push up costs in replacements, repairs, insurance rates, etc., and push down sales through personal apprehension or apprehension by family groups when purchase of a personal plane or travel by air is considered. The problem of safety in aviation, however, is not primarily one of financial loss. The first consideration of safety is injury—whether people are killed, seriously injured, or not hurt.

In extremely severe aircraft accidents there is no doubt about resulting injuries. The cockpit and cabin are demolished, the occupants killed, and we simply say that the people were killed by the crash. Injury in more moderate accidents, however, is not answered by the simple statement that people are killed or injured by the crash, for in the same accident one may be killed while another escapes unhurt. Even in severe crashes several may be killed and others not dangerously injured.

Variations in Degree of Injury

The wide variations in degree of injury sustained in many aircraft accidents have opened numerous questions as to why these extremes of injury and noninjury occurred. When results from large groups of accidents are analyzed, however, the causes of injury in a single crash are not so arbitrary or haphazard as they seem. Like any physical or mechanical result, crash injuries show definite patterns, and causes of fatality often are typical, are repeated, and result directly from dangerous details in cockpit or cabin design. In consequence, many accidents that could be survived now become "fatal" solely because of cabin dangers. These results are found more often in personal aircraft than in larger, heavier ships because speeds are lower, cabin structure holds, and fatal accidents of a survivable nature are more frequent in private flying. If popular flying is to reach its fullest safety and expansion, improved design of cabin installations in personal aircraft, therefore, assumes particular importance, along with constant effort toward accident prevention.

Air Line Versus Private Flying

In air-line operations, accidents can be avoided and safety records set by excellence of equipment, maintenance, judgment, and care. As a result, public fear of air-line travel now approaches the vanishing point, and business prospers accordingly. Margins of safety satisfactory to full expansion of private flying have not been achieved through accident prevention in the past, and we now look forward to thousands—we expect hundreds of thousands—of inexperienced people learning to fly, principally by flying. These people will be amateur flyers and not professional or full-time pilots. They will run out of gas, challenge bad weather, get lost, misjudge landings, take off into trees, and do all the other things that have caused personal flying accidents in the past. In order to protect themselves and the public from the inexperience, bad judgment, and carelessness of private pilots, manufacturers look with hope to simplified controls and improved flight characteristics.

Spinproofing, adequate stall warning, and other improvements will make flying easy and add new margins of safety through preventing inadvertent loss of control. With large expansions of popular flying, however, whether the number of fatal crashes is wholesale will depend only partly on the airworthiness of the ship, for, when a pilot gets his ship into trouble, the seriousness of results often will depend on where the occupants are placed in the structure, on the strength of the cabin, and on the design of its installations.

Up to the present, aircraft have been built solely to fly, not to crash. This single approach in design has been costly in the past and is no longer acceptable in military aircraft where a few pounds of extra weight to give added crash protection has been an important concession. In personal aircraft, whether cockpit or cabin details set up major dangers in an accident has not been fully recognized, except by pilots who made a livelihood in cracking up planes as an attraction at State Fairs or for the moving-picture industry. These men modified known cockpit dangers and thereby rode through large numbers of crashes with only minor injury. In all other private aircraft the cockpit has been designed principally as a housing and work place for the pilot and for the comfort of passengers in flight, and up to the present there has not been enough consideration of the part the cabin might play in protecting or endangering the occupants in an emergency. When pilots overshot landings or stretched glides, fouled trees, or got into serious trouble for other reasons, resulting injuries have been accepted as a matter of course. If one person got out of a crack-up with a sprained ankle or a broken arm, he was considered lucky; if he was unlucky, he was killed. This chance factor has often been observed and has given striking evidence that amazing degrees of both safety and danger can exist in the same accident.

Typical Injuries

In order to find out where crash safety begins and ends—and why—a study of crash injuries was undertaken in 1942 by the National Research Council in conjunction with the Safety Bureau of the Civil Aeronautics Board. Acting in cooperation with Army and Navy studies of accidents in military aircraft, facts have been found which now open new concepts of safe and dangerous relationships between the occupants of a plane and surrounding aircraft structure.

In order to understand what happens to the human body in a crash we must review briefly the typical injuries found by crash research among survivors of light aircraft accidents. If we understand the causes of these injuries, we can judge the probability of similar causes producing similar results in other aircraft. When the studies were undertaken, it was believed that severe accidents inevitably would cause large numbers of serious injuries of the torso. Frequent puncture wounds of the chest or abdomen were anticipated, as well as serious internal injuries such as lesions of the heart, liver, lungs, spleen, bladder, etc. There was, in fact, a widely held belief that the snubbing action of 2-in., 1,000-lb. safety belts caused internal injuries, and those who held these convictions preferred to take their chances rather than use a safety belt when a crash threatened. In severe accidents the safety belt was thought to cut people in two. No improvement of safety belts was possible while injury facts were unknown. Difficult as it is to believe, it has been found that, among

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Fig. 1.

thousands of injured survivors of military and civilian aircraft accidents, less than 1 per cent show evidence of internal injuries other than those of the head. This finding is especially significant when we consider the large number of safety belts that have been broken and the subsequent violence with which people are thrown onto each other or against forward seats and other structures.

It was also believed that shoulder harness would break pilots' necks and that either with or without harness the neck would be snapped almost inevitably by the general violence of a crash. This belief has also been proved unfounded as a typical cause of crash danger. Also, except in extreme accidents, chest injuries seldom are found, especially where the safety belts remain effective and control sticks are used. When serious injuries of the chest do occur in survivable accidents, they usually are caused by one passenger being thrown onto another or by dangers in control wheel design. The evidence throughout the studies has shown that the neck, chest, and abdomen can stand forces of extraordinary violence.

Fractures

As might be expected, fractures of the extremities were found to be frequent, but, although painful, they are considered relatively unimportant as a crash result. Even when several fractures occur, they seldom need to be regarded as dangerous. A broken arm or a broken ankle, or both, usually implies limited disability and hospitalization. Among survivors, traumatic amputation of the extremities, or need for subsequent amputation, is unusual.

This narrows findings on dangerous injuries among survivors to fractures of the lower spine and head injuries. These are serious. At present, there is an odd trend in crash data regarding spinal fracture in personal aircraft. Damage of that portion of the spine to which the ribs are attached is rare, but compression fractures of the lumbar spine are frequent. They occur in high-speed, low-angle crashes apparently due to heavy downward force after the landing gear washes out. The odd trend is that fractures of the lumbar spine were found in 13 per cent of the survivors in one type of aircraft and among less than 1 per cent of survivors in three makes of apparently similar aircraft under similar conditions. If this trend is continued, it will point to what normally would be expected—namely, that safe as well as dangerous seats, landing gear, etc., may be in common and often optional use but that their difference in safety and danger has not been known.

Head Injuries

Of all crash injuries, no typical result is so frequent and dangerous as injury of the head. The human head is hard; its 8–10-lb. weight exposes it to sledge-hammer blows, and it is exceedingly vulnerable. All its physical characteristics are against it. It dominates accident results. Often it is the only vital part of the body exposed to dangerous injury in a crash, and fatality from head injury alone is not uncommon without other marks of injury on the body. In severe crashes where cabin structure is not destroyed, injuries of the head, not the body, usually dictate the difference between fatality or less serious results.

Shoulder Harness

The findings we have reviewed on the nature of typical injuries among survivors allow simple conclusions: first, that the body can stand extraordinary force; secondly, that the head must be protected. Based on these facts, shoulder harness is now used in military aircraft and has been constantly increased in strength by observation of its effects, until today the combination of Navy safety belt and harness is designed to hold the pilot under 8,000 lbs. of force. Study of accidents indicates, however, that the end point of human safety factors in the neck and body has not been reached, and Army crash groups now propose reinforced "island-of-safety-cockpits" in which the structure, seat, safety belt, and harness will hold the pilot in negative accelerations up to 50*g*'s.

Although shoulder harness, with the Geohegan inertia locking device used in military aircraft, is the best and surest means of protection, strong anchorage for the harness and its routine use offer mechanical and psychological problems in popular flying and passenger planes. It is to be hoped that the use of the harness will become more general, but it is expected that this development will come slowly. Safety in popular and transport flying, however, can be greatly increased without using harness. The problem resolves itself into exploiting the newly found strength of the body—and lessening chances of head injury. This can be done by increasing the strength of safety-belt assemblies and by moderating or eliminating structures inside the cabin known to cause excessive dangers for the head.

Accident Analysis

The best way to understand what these dangers are is to see results in large numbers of accidents. The illustrations used are selected from many to show typical examples of danger in contemporary models of light planes. From these we can see what generally causes injuries and judge what gives danger or protection in many other types of aircraft. In many of the accidents illustrated the force was extremely severe. Light planes often hit vertically at 40–60 m.p.h. and stick like an arrow. In studying what happens to the occupants, let us remember our force formulas and realize that a cartwheeling or glancing accident at 100 or more m.p.h. can be far less dangerous than a vertical impact speed of 50 m.p.h. Also, high-speed collisions with trees or wires often moderate the force of a crash sufficiently to allow fair chances of survival if the seat belt holds and the cabin provides protection.

Vertical Impact

As our consideration is solely of moving up the margins of safety in survivable accidents, let us first dismiss from our minds the type of crash which is beyond the scope of this discussion. Fig. 1 is an example common to all aircraft when vertical high-speed impact occurs. Collision in the air, structural failure, or loss of control contribute to these extreme results. The problem is purely one of accident prevention. Obviously, accidents of this type are apart from any consideration of cabin construction or details. The cabin itself disintegrates. Under these conditions multiple fatal injuries are a normal expectation. In spin-resistant planes, accidents of this severity should be rare.

Fig. 2.

Fig. 3.

In crashes that are only slightly less severe, survivors are found occasionally. One person was killed in the wreck shown in Fig. 2; the other had a broken collar bone and a broken tooth. It is remarkable that relatively minor injuries could occur here. Survival was attributed to the safety belt holding and to the fact that the control wheels jammed in a rearward position and acted somewhat like shoulder harness to prevent rapid forward movement of the head and body. This extraordinary provision of safety by control wheels has been observed in a number of accidents. Notice in this accident, as in others illustrated, that injuries are not a direct function of crash force. This crash was extreme, but possibly it would not have been fatal if both control wheels and safety belt assemblies had remained intact. In this case one person broke both the belt and control wheel and sustained multiple fatal injuries.

Chance—Not Luck

Survival in crashes of this type have commonly been called "luck." Luck, however, by definition, is only "that which seemingly happens to one by chance." The chances in the case shown in Fig. 2 were bad but survival occurred. In other accidents where the chances are good, people are killed. Crash research seeks factors in aircraft structure which set up good or bad chances of safety; the study is not, as many have thought, merely a matter of recording the number of injuries sustained in aircraft accidents. If it were, we would add one broken collar bone and one broken tooth to recorded numbers of injuries and stop there. Nothing would be gained. It is true that safety rates are computed against numbers of injuries, but the core of safety is not in knowing numbers of injuries but in finding what causes danger. In this crash, as in others, not luck but definite factors in the human body and in the engineering of aircraft structure and cabin details established this unexpected chance of safety.

Collapse of Cabin Structure

The surest cause of danger in any accident is collapse of cabin structure. When this occurs, safety is beyond control and survival is unusual. So long as the cabin or cockpit holds its general shape, chances of safety exist and safety measures can be effective. The combination of shoulder harness and safety belt, for instance, provides amazing degrees of protection where cockpits remain intact. In the crash shown in Fig. 3 the ship hit at a 30° angle at an estimated speed of 70 knots. The force destroyed most of the structure except the empennage and cockpit. The cockpit itself had started to buckle longitudinally. The wings and other component parts are more or less in their original position but fell apart during salvage operations. This rugged ship literally had to be picked up in pieces. The pilot was wearing shoulder harness and, as a result, was flying 4 days later.

If a safety belt alone had been used in crashes such as those illustrated in Figs. 3 and 4, the chances of severe or fatal head injury would have been high, although fractures of the extremities or other material injuries were not probable. In military ships such as these, a great deal already has been done to lessen dangers of head injury—by improving the placement and design of windscreen structures, gun sights, etc., and by strengthening, properly proportioning, and streamlining the inside of the cockpit.

Because of the multiplicity of cockpit details and instruments in large planes, a high degree of safety for the head by cockpit design alone is out of the question. Harness is the best and only answer; its use allowed the pilot to walk away from the high-speed cartwheeling crash shown in Fig. 4 with only minor bruises.

Safety-Belt Strength

When safety belts only are used—and they fail—the user is thrown forward in a jackknife position and the head is exposed to any and all dangers; usually the effect is that of being catapulted into forward wreckage head first. In the crack-up shown in Fig. 5 the pilot was in the rear seat. The surrounding structure is in good condition, but the safety belt broke and the pilot was thrown forward and through the side of the cockpit. He died subsequently from head injuries—there were no fractures of the extremities or other lesions of consequence. (Among more than 100 persons who have survived belt failures like this, we have been puzzled to know how the head can be exposed to such severe conditions without finding strains of the neck or minor cervical fractures.)

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7. Mid-air collision. No injuries.

Because of many ramifications we can only generalize on the subject of safety-belt strength. It would be difficult to anchor the 5,000-lb. belt used in military aircraft in the nose of a fragile sailplane. In transport ships and in each aircraft there is a separate problem. As a general rule it can be said only that the strength of the safety belt assembly should materially exceed that of longitudinal structure. Today this condition is not met in light planes. In the rear seat of light tandem planes, neglect of this consideration has led to failure of the safety belt among 47 per cent of the survivors. How this 47 per cent survived is something to think about, for the usual saying is "after the belt breaks, God help you." In one model 70 per cent of the survivors were exposed to unnecessary degrees of danger through failure of fastenings of the seat to which the belt was attached. This is a credit to the human body, not to the design of safety-belt installations. In private aircraft, no seat belt should be classed as a safety belt unless the assembly—webbing, hardware, and anchorage—has a minimum strength of 2,000 lbs.

Survival certainly seems like a rare chance when safety belts break in accidents like the one shown in Fig. 6. Here the pilot was in the rear seat; the belt broke and he hit forward wreckage head first. Head injury naturally dominated the results. There was a fracture of the skull with moderate concussion; no other fractures or serious injuries were found. If we narrow down the cause of injury, we find that it was not the crash but safety-belt failure that nearly killed this pilot.

Notice in this accident, and in others, that forward sections are telescoped; the energy usually is absorbed there or the force in high angle crashes would mount beyond hope of survival. If the front seat had been occupied, the crash would normally have been classed as fatal. Actually, in this case the investigator's opinion was that "no injuries would have occurred in the rear seat if the safety belt had held." This may be hard to believe, but the opinion is justified; it should be hedged only by adding—"if the pilot's head had missed the steel back rest of the forward seat." This installation alone has killed more popular flying enthusiasts than any of us would care to count. Padding the back of the forward seat with foam rubber only disguises its danger. When the head hits the results are like striking an anvil. We do not suggest wicker seat backs in transport or private planes, but there apparently are unlimited possibilities of designing safer seats than those used at present. The suggestion has been made that backs of forward seats in small ships, no matter how constructed, be allowed to pivot forward 30°–40° so that the head of the occupant of the rearward seat would have a better chance; for, when the safety belt holds and the head misses forward seat structure, occupants of rear seats have walked away from any number of accidents such as those shown in Fig. 7.

At present, the chance of walking away from serious accidents such as these is poor because 1,000-lb. belts usually fail when needed in crashes of this severity. In the few cases where they hold, there is only about a 40 per cent chance of the head missing dangers from the back of the forward seat in planes of this general type.

Design for Safety

Seating

To offset hazards of head injuries from forward seats in multiplace passenger aircraft, the idea has often been proposed of seating passengers facing aft. This arrangement is now being tried by

the Navy to see whether psychological factors outweigh advantages. By seating passengers aft as far as possible and facing seats toward the rear, chances of safety would be greatly increased. In the event of a crash landing, the heads and bodies of passengers would be fully supported to give "fire-net effects" until the seats or rearward cabin structure failed.

Even now, with danger of being thrown by failure of the safety belt or of whipping forward over the belt and striking the back of the forward seat, the difference in exposure to danger between forward and rearward positions in all aircraft is marked. We see constant evidence of this in accidents involving both light and heavy ships. Quoting *The Air Surgeon's Bulletin* of the Army Air Forces on advantages of rearward seating, we note that "an analysis of casualties and fatalities in twenty crash landings in B-24 type aircraft showed that persons in the rear (waist) are seven times less likely to die, three times less likely to have serious injuries, and three times more likely to have no injuries than those forward of the leading edge."

Among survivors in crashes of light planes, analysis has shown that, even with high rates of belt failure, injuries to occupants of rear seats are, on an average, 53 per cent less severe than those in forward seats. If the strength of safety belt assemblies is increased from 1,000 to 2,000 lbs., and if the back of the front seat is made less dangerous, this 53 per cent safety advantage of rearward seats undoubtedly would be increased to an amazing degree and would allow, for the first time, definite judgment of what can be done with safety belts and rearward seating to give optimum protection—not only in private planes but also in military and commercial air transport.

Control Wheels and Instrument Panel

Although there are similarities between the action of safety belts and relative exposures to injury in the rearward seats of aircraft generally, when we come to consideration of cockpits in the nose of heavy transport planes and those in light personal aircraft, we find no common ground for comparison. Safer control wheels and safer instrument panel arrangements are preferable to dangerous ones in all ships, but their value is rarely seen in transport aircraft because of a low frequency of accidents in which they alone constitute the principal danger.

In personal aircraft, however, the design of control wheels and instrument panels is a serious safety problem, for they frequently change what might have been a dangerous mishap into a fatal accident.

When a safety belt alone is used, the velocity of upper parts of the body is not materially checked and control wheels and instrument panels are the usual targets for the head. The design of these installations, therefore, often rules the total severity of injuries.

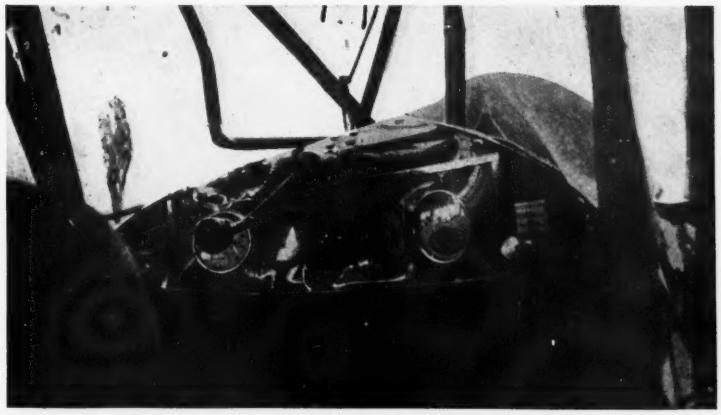


Fig. 8.

Instrument Panels.—If all parts of past instrument panels had been made of solid, unyielding structure, many of the best men in aviation would not be with us today. Many fliers have been spared, as was the case in the accident shown in Fig. 8, while others were critically injured or killed merely because, by pure chance, their heads hit yielding instead of solid panel areas. Solid areas in panels are not made of cast iron but often are backed up by structure that is just as dangerous. In many aircraft now bidding for popular favor, panels are studded with obvious and needless dangers. Placing a heavy flight instrument or a parking brake handle or a starter crank, such as shown in Fig. 8, in the middle of the panel may seem a minor hazard, but casualties caused by such objects add more fatalities to private flying today than structural failures in the air, fire in the air, and many other dangers that have been offset by improved design.

Modification of head injuries often would result from mere rearrangement and better placement of panel details, but the needs of safety in popular flying deserve further thought than this. The panel should not have a hard, sharp upper edge. Transverse bracings, tube clusters, and other solid objects should not be immediately behind the panel. It should not be crowded against header tanks, and as much space as possible should be provided between it and forward objects to lessen dangers when collapse of forward sections occurs.

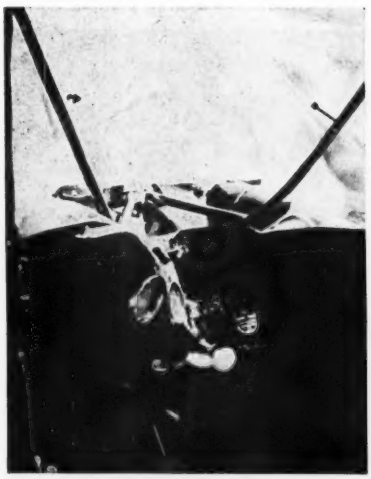


Fig. 9.

In dealing with the instrument panel and its details, the thought throughout should be of lessening danger for the head when it strikes the panel at high impact velocities. With normal resourcefulness, major improvements may be achieved without significant changes in cost, weight, or function.

Many suggestions for improvement have been made. One idea that has been backed by observations in crash research is to keep the panel facing and the instrument mount separate and have the mount with its heavy instruments so arranged that it can fly forward under heavy crash force. This would eliminate many dangers now caused by panel details that are held in positions where they expose the head to hammer-like blows and inflict fractures of the skull and facial bones. Any object in the panel that can cause danger for the head at impact velocities of 50 ft. per sec. should be allowed to shear free under heavy inertia force before the head strikes. Amazing results have been seen where this happened by chance, and these chances surely can be improved by design. In the accident illustrated in Fig. 9, the plane spun in; the pilot's head struck the upper central portion of the panel and dented this structure deeply. He walked away with no other injury than a cut on the forehead. If a heavy compass or reinforcement had been fixed in the upper area of this panel, another fatality would have been scored against private flying and future sales.

With a strong ductile panel facing, free of solid objects and projections, the head can be stopped from high velocities without important injury. In other than aircraft accidents, cases are on record where the head has been stopped from velocities of 70 ft. per sec. in less than 6 in. without skull fracture or loss of consciousness. The skull cannot be fractured against a broad metal surface that will yield and cushion heavy blows,

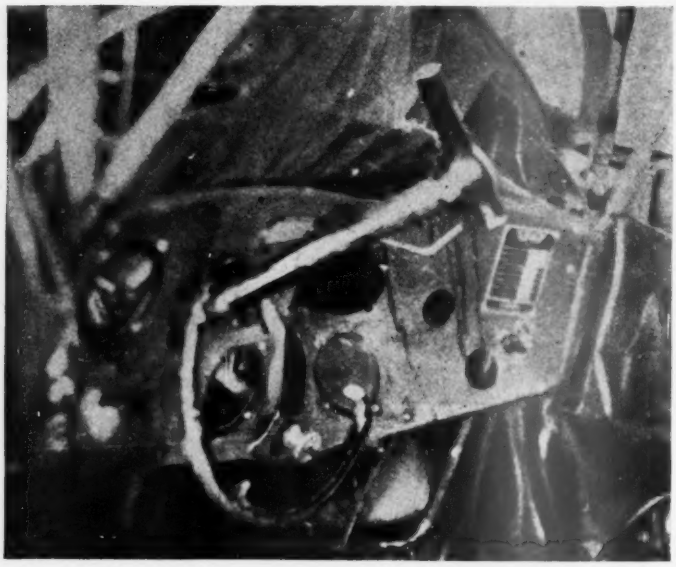


Fig. 10.

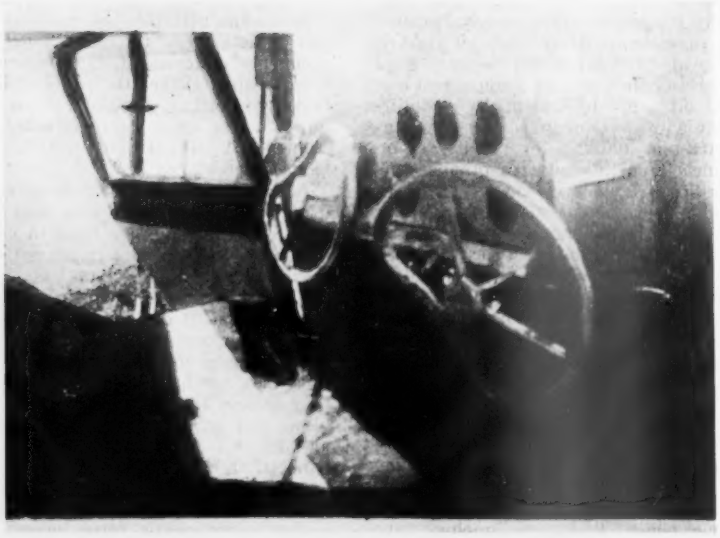


Fig. 11.

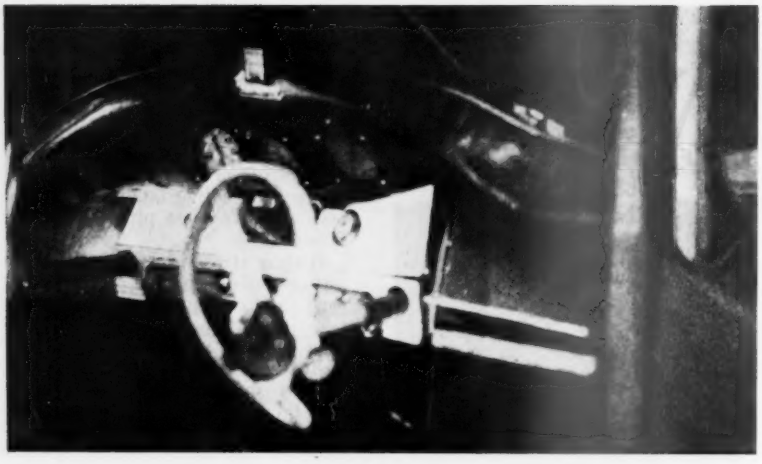


Fig. 12.

and the evidence today is that, as a cushioning medium, nothing is better than light sheet metal, 0.040 to 0.060 in. in thickness. This appears to be more satisfactory than deep sponge rubber or any other known padding, because full energy absorption begins with the first denting of the surface and continues without seriously increasing peak force or danger. Thus, a blow sufficient to cause a $^1/_2$-in. dent in a ductile surface may daze a man, while a 6-inch dent may produce no greater evidence of injury. This appears to be what happened in Fig. 9, and similar results have been noted in other cases. Fundamentals of safety will be neglected in popular flying until instrument panels are designed to spare head injury to the fullest possible degree.

Control-Wheel Installations.—Next to the instrument panel, no single detail in personal aircraft needs more safety thought than control-wheel installations. In accidents where the force is not severe and collapse of cabin structure is not even threatened, control wheels alone often cause serious or fatal results. Here, however, the safety problem is complicated, for the wheel is often in different positions to meet varying needs of control just prior to an accident. In some cases the wheels are slammed forward by the force of the crash and are within forward range of the head. In other crashes, collapse of forward sections drives the push-pull tubes into the cabin, ramming the control wheels against the pilot. Evidence indicates that the pilot most often pulls the controls back as far as possible in the last moment of an emergency, for the push-pull tubes frequently are found bent and jammed in this rearward position.

In the past, design of control-wheel installations has varied with each aircraft and often with each model. Some have been excessively dangerous. By illustrating a few examples from crash experience, we can judge how serious these dangers are before referring briefly to present efforts toward safety.

In the accident illustrated in Fig. 10, the cast dural wheel apparently was thrown forward and then was rammed back against the pilot's head. The injuries were critical: the pilot was unconscious for 2 weeks. There was no control wheel installed in front of the passenger and he struck a less severe object with the result that he was unconscious for only 1 hour. In addition, he had minor sprains but was out of the hospital in 3 days.

The crash illustrated in Fig. 11 was not of a fatal type, but head injuries sustained by each person were so severe that they bordered on fatality. Each had a critical head injury caused when the head was flung forward and downward against the wheels in their forward position.

The aircraft in the accident shown in Fig. 12 overshot a field and stopped abruptly in a ditch. The pilot was thrown directly forward against the other wheel in this ship. The rim bent away from the hub and caused fatal

Fig. 13.

puncture injuries of the chest. The passenger apparently hit this wheel a glancing blow, then struck and dented the dash with his head. His only injuries were a bruise on the forehead and a mild concussion headache. If these wheels had been stronger and had been checked in a fully rearward position, dangerous injuries of any kind would have been unlikely. Notice the condition of the cabin in this accident and how various details of cabin design contributed directly to fatality for one person and moderate injuries for another. If we are to have greater safety in future mishaps of private flying, the problem of dangerous push-pull tube and control-wheel installations will have to be answered.

As the purpose of crash research is not solely to find causes of injury and as we are equally concerned to find what causes unusual degrees of safety in crashes such as that illustrated in Fig. 13, we were puzzled for a long time to know why serious or fatal head injuries sometimes did not appear in accidents of this severity. The causes seem to be specific. Apparently the pilot often pulls the controls full aft and braces instinctively at the last second, and in certain accidents where large, rugged control wheels are used, any subsequent bending or blocking of the push-pull tubes checks high forward velocities of the chest and head. The results are very much like those found with a shoulder harness. The control wheels illustrated in Fig. 13 were not designed like those used in automobiles to spare the chest, yet the amazing thing is that bruises of the chest were not severe. In this accident one person had trivial injuries; the other had fractures of the extremities and minor bruises of the chest.

We do not need evidence from hundreds of future mishaps to know control-wheel dangers. When the wheels slam forward, the head is likely to strike them causing fractures of the skull and facial bones. When they are rammed back, anything can happen; but when they are held back, they are in their safest position and occasionally give amazing protection.

We have the wheels and push-pull tubes. Why not design them to give definite protection more often? All that seems needed is a rugged, resilient wheel to distribute loads on the chest and an inertia gadget to check rapid forward movement of the push-pull tubes. This inertia drag or lock (such as indicated in Fig. 14) need not be in contact with the tubes under any conditions except those set up by crash force.

If ingeniously designed, the cost and weight of this improvement would be inconsequential as compared with results. Steering wheels in automobiles have been developed to give the driver high degrees of safety. Owners of personal planes surely merit this same protection. In private aircraft a strong belt and a safety wheel might be better than shoulder harness because of psychological reactions against the use of harness and because we find that the harness is not worn routinely in casual flying—even where it is installed.

Conclusions

In studying accidents we reach conclusions that cannot be avoided. People can stand the force of serious crashes. They have survived in the past by mere chance, in face of many formidable and unnecessary cabin dangers. Until recently, optimum protection has not been studied and, therefore, could not be provided. Research now shows that accidents can be less dangerous and that

Fig. 14.

serious and fatal injuries often are caused by specific dangers built into the cabin. There can be no criticism of designers or manufacturers in this, because repeated causes of injury were not analyzed and the unexpectedly large safety factors in the human body were not known.

Use of the strength of the human body will play an important part in aviation's future safety problems. Personal pilots will continue to cause accidents, but, fortunately, much can be done to lessen the industry's costly penalties of the past.

Manufacturers of personal aircraft are making changes that will cut rates of fatality in crashes materially. Some estimate a 10 per cent increase of safety with nominal cabin improvements; others believe that a 50 per cent increase in the safety of private flying is possible by spinproofing the ship and by providing protection in emergencies by improved cabin design. New safety records undoubtedly will be set in certain aircraft, and these will be watched with interest by the public and throughout the industry.

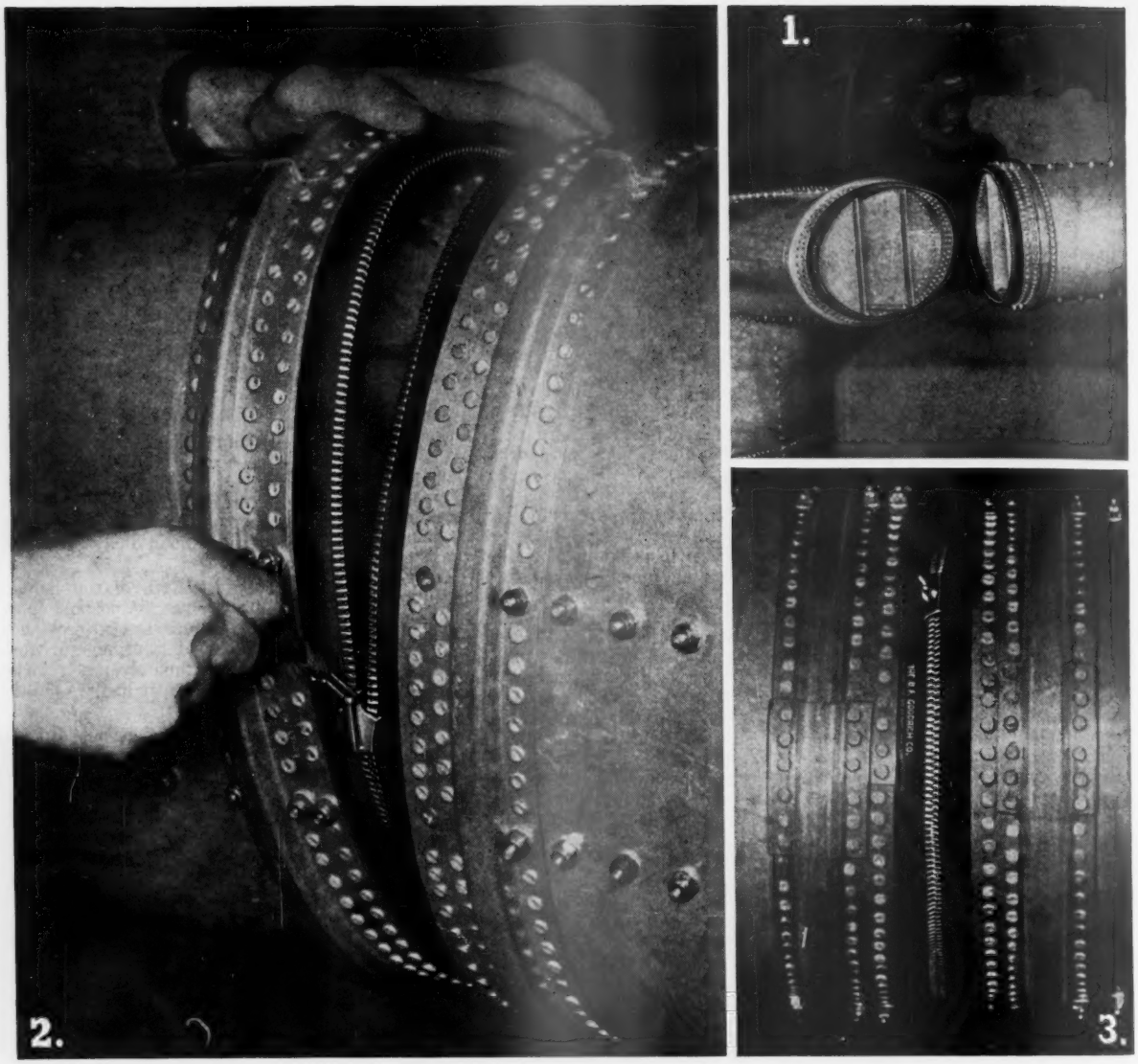
Half a million unskilled pilots will present aviation with serious safety problems. If large numbers of amateur fliers get themselves into accidents, their safety will often depend on the safety belt, instrument panel, control wheel, and cabin that will afford the best chances of safety. With the unexpected reserves of strength found in the human body, these chances can be amazingly good.

Plan Now to Attend

Annual Summer Meeting, Los Angeles, Calif., July 18–19, 1946

Technical Sessions — Royce Hall, U.C.L.A.

Dinner — Hotel Ambassador, July 19



How to zip an airplane's windpipe

TORNADOES of air are sucked in, rammed through, and rocketed out behind four huge propjet engines of the new XF-12, military prototype of the Republic "Rainbow" Transport. All this air roars through long, winding ducts . . . and these "windpipes" used to be problem children.

Ducts had to be made in sections. Sections had to have tight joints because air goes through under heavy pressure. Yet the joints must be easily disconnected and re-sealed to permit frequent removal and replacement of duct sections. And that was a puzzler.

A new type of B. F. Goodrich Zipper supplied the answer. Not the ordinary kind, but one that's made with a precision-molded rubber seal that opens and closes with the zipper. A unique arrangement of overlapping rubber lips provides an effective seal for pressures up to the structural strength of the zipper itself.

These Pressure-Sealing Zippers make duct sealing an amazingly simple operation as shown in the 1-2-3 sequence above. Note that the molded lips go all the way around, to give 100% effective seal. This feature works equally well on kidney-shaped ducts or other odd shapes where clamps will not work. The zipper is a space-saver, too. It requires no cumbersome end connections and occupies no more space than an ordinary zipper.

Today there are many important and interesting aeronautical applications for B. F. Goodrich Pressure Sealing Zippers. Get more complete facts by writing to The B. F. Goodrich Company, Aeronautical Division, Akron, Ohio.

B.F. Goodrich

FIRST IN RUBBER

Institute News

Institute Members on Carrier Cruise and Tour of Naval Air Test Center as Guests of U.S. Navy

On April 29 and 30, 103 members of the Institute took part in a cruise on an aircraft carrier and an inspection tour of the Naval Air Test Center at Patuxent River, Md., at the invitation of Secretary of the Navy James V. Forrestal.

The group boarded the carrier U.S.S. "Tarawa," commanded by Capt. Alvin I. Malstrom, U.S.N., at Fort Hamilton, N.Y., at 11:00 a.m. on April 29. The cruise afforded the opportunity to witness the operation of an aircraft carrier's equipment and facilities. During the journey, demonstrations were given of the take-off and landing of Navy fighters, fighter bombers, and torpedo bombers; of the catapulting of planes from the flight deck, and of various flying formations of the carrier's planes. The group witnessed the experiences of a simulated battle, during which rockets were launched at targets and the carrier's planes engaged in tactical battle maneuvers.

The members went ashore at Norfolk, Va., on April 30 and were flown by the Naval Air Transport Service to the Naval Air Test Center at Patuxent River, where they were received by Capt. J. D. Barner, U.S.N., Commander of the Naval Air Test Center, and members of his staff. Soon after their arrival, they were shown an exhibit of Ground Controlled Approach Equipment, the system by which radar operators on the ground determine the location of the aircraft in poor visibility and give the pilot instructions by radio to enable him to land accurately. The group then witnessed the catapulting of a P-80 airplane.

After luncheon at the Officers' Club, the members visited the Flight Test Landplanes Hangar. They were shown a jet-assisted take-off of a JM-1, after which they inspected the planes on the line. Following demonstrations of Navy fighters and of a helicopter, the group proceeded to the Armament Test Area, where they were shown the Armament Test Ground Firing demonstration and the Armament and Tactical Test Air Firing demonstration, consisting of the target firing of rockets and guns both on the ground and in the air. Also shown was the firing of the "Tiny Tim" Rocket. The members were then taken to the West Seaplane Hangar for an inspection of Japanese aircraft and the Mars flying boat.

Naval officers included in the group making the tour were: Rear Adm. Lewis B. Combs, Bureau Yards and Docks; Rear Adm. Luis de Florez, Assistant Chief of the Office of Research and Inventions; Rear Adm. Austin K. Doyle, Assistant D.C.N.O. for Air; Rear Adm. Sherman S. Kennedy, Bureau of Ships; Rear Adm. Harold B. Miller, Director of Public Information; Rear Adm. Harold B. Sallada, Chief, Bureau of Aeronautics, Navy Department; and Commodore Henry A. Schade, Bureau of Ships.

Proceeding to the Naval Air Transport Service Terminal, the members assembled for a group picture. At 4:20 p.m., the N.A.T.S. flew the members of the group to Washington, Philadelphia, and New York.

A complete list of those who made the trip follows:

E. E. Aldrin, Aviation Manager, Atlas Supply Company.
D. W. Anderson, Vice-President, Firestone Aircraft Company.
Karl Arnstein, Chief Engineer and Vice-President, Goodyear Aircraft Corporation.
B. N. Ashton, President, Electrol, Inc.
L. A. Baldwin, Vice-President, Johns-Manville Sales Corporation.
Preston R. Bassett, President, Sperry Gyroscope Company, Inc.
W. H. Beech, President, Beech Aircraft Corporation.
Rex B. Beisel, Manager, Chance Vought Aircraft Division, United Aircraft Corporation.
L. D. Bell, President, Bell Aircraft Corporation.
D. S. Bixler, Manager, Aviation Department, Sinclair Refining Company.
N. Jay Boots, President, Boots Aircraft Nut Corporation.
George W. Brady, Chief Engineer, Propeller Division, Curtiss-Wright Corporation.
Forest S. Burtch, Manager, Aircraft Products, John A. Roebling's Sons Company.
H. H. Butner, President, Federal Telecommunication Laboratories.
H. C. Carroll, Engineer, Aeronautic and Marine Division, General Electric Company.
Reed M. Chambers, President, United States Aviation Underwriters, Inc.
H. Church, Vice-President, The Weatherhead Company.
E. W. Cleveland, The Cleveland Pneumatic Tool Company.
Reginald M. Cleveland, I.A.S. Aeronautical Archives.
Charles H. Colvin, Consultant, U.S. Weather Bureau.
W. W. Cowgill, Project Manager, Development Department, United States Rubber Company.
James A. Daley, Edwin J. Webb, Inc.
Harvey N. Davis, President, Stevens Institute of Technology.
C. W. Deeds, President, Niles-Bement Pond Company.
Carl de Ganahl, Director of Research, Fleetwings Division, Kaiser Cargo, Inc.
Robert R. Dexter, Secretary, Institute of the Aeronautical Sciences.
Hugh L. Dryden, Assistant Director, National Bureau of Standards.
William Dzus, President, Dzus Fastener Company, Inc.
Graham Edgar, Vice-President and Director of Research, Ethyl Corporation.
Howard E. Egert, Aircraft Industrial Manager, Owens-Corning Fiberglas Corporation.
Allan D. Emil, Counsel, Institute of the Aeronautical Sciences.
W. R. Enyart, President and General Manager, Simmonds Aerocessories, Inc.
Sherman M. Fairchild, Fairchild Camera & Instrument Corporation.
Richard E. Fell, Eastern Regional Vice-President, Pennsylvania-Central Airlines Corporation.
James G. Flynn, Jr., Vice-President in Charge of Operations, American Overseas Airlines, Inc.
Jack Frye, President, Transcontinental & Western Air, Inc.
C. C. Furnas, Director, Cornell Aeronautical Laboratory.
Lester D. Gardner, Chairman of the Council, Institute of the Aeronautical Sciences.
C. D. Geer, Vice-President, Thomas A. Edison, Inc.
Harold E. Gray, Assistant General Manager, The BG Corporation.
A. J. M. Hamon, Assistant Manager, Central Aviation Department, Shell Oil Company.
F. T. Harrington, Vice-President, Vickers, Inc.

I.A.S. Annual Summer Meeting

Royce Hall, University of California at Los Angeles, July 18–19, 1946

THURSDAY, JULY 18 — 9:30 A.M. TO 12:00 — FLIGHT TESTING

Chairman: J. F. Parsons, Assistant Engineer-in-Charge, Ames Aeronautical Laboratory, N.A.C.A.

Flying Qualities Requirements for Military Aircraft—Lt. M. J. Abzug, U.S.N.R., Flying Qualities Specialist, Aerodynamics and Hydrodynamics Branch, Bureau of Aeronautics.

Why Flight Test?—A. C. Reed, Aviation Consultant.

High Speed Wing Section Development Through Flight Testing—E. J. Horkey, In Charge of Aerodynamics, North American Aviation, Inc.

THURSDAY, JULY 18 — 1:30 P.M. TO 5:00 P.M. — AERODYNAMICS

Chairman: Clark B. Millikan, Acting Director, Guggenheim Aeronautical Laboratory, California Institute of Technology

Supersonic Aerodynamics from a Physical Point of View—F. H. Clauser, Head of Development Research Group, Santa Monica Engineering Division, Douglas Aircraft Company, Inc.

Further Developments in the Investigation of the Interaction Between Boundary Layer and Shock Waves—H. W. Liepmann, California Institute of Technology.

A Concept of Jet Aircraft Utilizing Boundary Layer Air for Propulsion—A. M. O. Smith, Preliminary Design Aerodynamicist, and H. E. Roberts, Aerodynamic Engineer, El Segundo Engineering Division, Douglas Aircraft Company, Inc.

Research Studies Directed Toward the Development of Rational Vertical-Tail Load Criteria—Lawrence A. Clousing, Ames Aeronautical Laboratory, N.A.C.A.

THURSDAY, JULY 18 — 7:30 P.M. TO 10:30 P.M.—AIRCRAFT DESIGN

Chairman: Edward Schmued, Assistant Chief Engineer of Design, North American Aviation, Inc.

Engineering Development of the Rainbow—Alexander Kartveli, Vice-President and Chief Engineer, Republic Aviation Corporation

Design and Development of the Douglas B-42—C. C. Wood, Head of Preliminary Design, Santa Monica Engineering Division, Douglas Aircraft Company, Inc.

Air Documents Division Progress with Respect to Usefulness in the Aeronautical Sciences—Col. H. M. McCoy, Chief, Air Documents Division of Intelligence (T-2), Air Matériel Command, Wright Field, Ohio.

FRIDAY, JULY 19 — 9:30 A.M. TO 12:00 — STRUCTURES SYMPOSIUM

Chairman: C. R. Strang, Chief, Structures and Weights Section, Santa Monica Engineering Division, Douglas Aircraft Company, Inc.

L. R. Jackson, Battelle Memorial Institute.
J. R. McBrearty, Division Engineer, Structural Engineering, Lockheed Aircraft Corporation.
M. A. Miner, Strength Test Engineer, Santa Monica Engineering Division, Douglas Aircraft Company, Inc.
R. L. Schleicher, Chief Structures Engineer, North American Aviation, Inc.
George Snyder, Staff Engineer, Structures, Boeing Aircraft Company
R. V. Rhode, Chief, Aircraft Loads Division, Langley Aeronautical Laboratory, N.A.C.A.

FRIDAY, JULY 19 — 1:30 P.M. TO 4:30 P.M. — PROPULSION METHODS

Chairman: William Bollay, Head of Technical Research Laboratory, North American Aviation, Inc.

Progress in the Development of Rockets—N. B. Moore, Research Manager, Aerojet Corporation.

Current Problems in Developing Major Components for Aviation Gas Turbines—A. H. Redding, Section Engineer, Aviation Gas Turbine Division, Westinghouse Electric Corporation.

An Approach Toward Increased Performance of the Turbo Jet—Nathan C. Price, Director of Power Plant Engineering, Menasco Manufacturing Company.

FRIDAY, JULY 19, 8:00 P.M. — INFORMAL DINNER — Ambassador Hotel, Los Angeles, Calif.

Gen. H. H. Arnold will be the principal speaker at the Dinner. The subject of his talk will be announced in a final program to be mailed to all members. The final program will also give the names of other distinguished guests and further information about the Dinner.

R. Paul Harrington, Head, Department of Aeronautical Engineering, Polytechnic Institute of Brooklyn.
L. I. Hartmeyer, Vice-President, The Aviation Corporation.
Elmer Haslett, President, Westchester County Airport.
G. H. Hauser, Vice-President, Liberty Aircraft Products Corporation.
Paul E. Hemke, Head, Department of Aeronautical Engineering, Rensselaer Polytechnic Institute.
Bennett H. Horchler, Executive Vice-President, Institute of the Aeronautical Sciences.
S. Paul Johnston, Director, Institute of the Aeronautical Sciences.
C. S. Jones, President, Casey Jones School of Aeronautics.
Roger Wolfe Kahn, Test Pilot and Manager of Service Department, Grumman Aircraft Engineering Corporation.
W. Wallace Kellett, President, Kellett Aircraft Corporation.
W. D. Kennedy, Vice-President and General Manager, Wright Aeronautical Corporation, Division of Curtiss-Wright Corporation.
Dan A. Kimball, Vice-President and Manager, Aerojet Engineering Corporation.
Otto E. Kirchner, Director of Aircraft Engineering, American Airlines System.
Harold L. Knoop, Superintendent of Flight Operations, United Air Lines, Inc.
W. E. Kuhn, Manager, Technical and Research Division, The Texas Company.
James D. Landauer, I.A.S. Aeronautical Archives.
R. P. Lansing, Vice-President, Bendix Aviation Corporation.
H. R. Larsen, Chief Engineer, W. & L. E. Gurley.
Robert B. Lea, Vice-President, Sperry Gyroscope Company, Inc.
Jerome Lederer, Assistant Manager and Chief Engineer, Aero Insurance Underwriters.
E. A. Link, President, Link Aviation Devices, Inc.
William Littlewood, Vice-President—Engineering, American Airlines System.
S. H. MacArthur, Vice-President, The New York Air Brake Company.
C. Hart Miller, Aircooled Motors Corporation.
Richard M. Mock, Vice-President, Lear Incorporated.
Edward A. Mooers, Vice-President and General Manager, The Hilliard Corporation.
A. T. Murray, Vice-President, Moore Drop Forging Company.
C. F. Nagel, Jr., Chief Metallurgist, Fabricating Division, Aluminum Company of America.
A. T. Newell, President, Kenyon Instrument Company, Inc.
William O'Neill, President, The General Tire & Rubber Company.
Earl D. Osborn, President, Edo Aircraft Corporation.
Will D. Parker, Manager, Aviation Division, Phillips Petroleum Company.
Mundy I. Peale, Vice-President, Republic Aviation Corporation.
J. S. Pedler, Manager, Aeronautical Division, The B. F. Goodrich Company.
E. H. Plesset, Assistant Research Manager, Research Laboratory, Douglas Aircraft Company, Inc.
Andre A. Priester, Vice-President and Chief Engineer, Pan American World Airways System.
D. B. Robinson, Secretary, Warren McArthur Corporation.
Laurance S. Rockefeller.
Harry Rogers, President, Polytechnic Institute of Brooklyn.
John A. Sanborn, General Manager, Manufacturers Aircraft Association.
George C. Satris, Inco Nickel Alloys Division, The International Nickel Company.
E. M. Scott, President, Scott Aviation Corporation.
F. H. Sharp, Design Engineer, Consolidated Vultee Aircraft Corporation.
Robert T. Skinner, Vice-President, Skinner Purifiers, Inc.
Elmer A. Sperry, Jr., Vice-President and Treasurer, Sperry Products, Inc.
Robert Stoddard, Vice-President, Wyman-Gordon Company.
Ernest G. Stout, Head of Naval Aircraft Research, Consolidated Vultee Aircraft Corporation.
Fred K. Teichmann, Head, Department of Aeronautical Engineering, New York University.
Ralph H. Upson, Consultant, Power Equipment Company.
Guy W. Vaughan, President, Curtiss-Wright Corporation.
Jack Vaughan, Chief Engineer, The W. L. Maxson Corporation.
John F. Victory, Executive Secretary, National Advisory Committee for Aeronautics.
Paul F. Voigt, Jr., Carnegie-Illinois Steel Corporation.
Th. von Kármán, Director, Scientific Advisory Group, Office of the Commanding General, Headquarters Army Air Forces.
J. Carlton Ward, Jr., President, Fairchild Engine and Airplane Corporation.
Smith Webb, Edwin J. Webb, Inc.
B. L. Whelan, General Manager, Sikorsky Aircraft Division, United Aircraft Corporation.
A. V. D. Willgoos, Chief Engineer, Pratt & Whitney Aircraft Division, United Aircraft Corporation.
G. H. Woodard, Manager, Aviation Gas Turbine Division, Westinghouse Electric Corporation.
Cole Younger, Vice-President, Chase National Bank of the City of New York.

Medal for Merit to Institute Members

Dr. Karl T. Compton, President of the Massachusetts Institute of Technology and a Fellow of the Institute, has been awarded the Medal for Merit "for outstanding services to his country" in the development of microwave radar. The Medal, the highest award that can be bestowed on a civilian by the U.S. Army, was presented to Dr. Compton by Lt. Gen. O. W. Griswold, Commanding General of the First Service Command.

Leroy R. Grumman, President of Grumman Aircraft Engineering Corporation and a Fellow of the Institute, has been given the Medal for Merit by Secretary of the Navy James Forrestal for his contribution to the effectiveness of United States naval aviation.

Shell Union Makes General Doolittle a Director

Lt. Gen. James H. Doolittle, a Fellow and Past-President of the Institute, has been elected to the Board of Directors of the Shell Union Oil Corporation, in addition to his present post as Vice-President of the company. His election took place on April 18, the fourth anniversary of his having led the first bombing of Tokyo.

Dr. Hunsaker Elected Director of Two Companies

Dr. J. C. Hunsaker, Chairman of the National Advisory Committee for Aeronautics and an Honorary Fellow and Past-President of the Institute, has been elected a Director of the Shell Union Oil Corporation and a Director of McGraw-Hill Publishing Company. Dr. Hunsaker is also Head of the Departments of Mechanical and Aeronautical Engineering at the Massachusetts Institute of Technology.

Executive Changes in American Airlines Organization

At the request of the War Department, Sumner Sewall, President of American Overseas Airlines, Inc., and an Industrial Member of the Institute, has been released by that company to undertake an important Government assignment. Brig. Gen. Harold R. Harris, Vice-President and General Manager of the company and an Associate Fellow of the Institute, has been elected to the Board of Directors, succeeding Mr. Sewall. Major Gen. C. R. Smith, Chairman of the Board of American Airlines System and an Industrial Member of the Institute, has been elected President of American Overseas Airlines, Inc., to succeed Mr. Sewall.

Appointments to the N.A.C.A.

Arthur E. Raymond, Vice-President in Charge of Engineering of the Douglas Aircraft Company, Inc., and President and Fellow of the Institute, and Ronald M. Hazen, Chief Engineer of the Allison Division of General Motors Corporation and a Fellow of the Institute, have been appointed by President Truman to the National Advisory Committee for Aeronautics. Mr. Raymond and Mr. Hazen will fill vacancies created by the retirements of Dr. William F. Durand, Professor Emeritus of Mechanical Engineering at Stanford University and an Honorary Fellow of the Institute, and of Dr. Edward P. Warner, President of the Interim Council of the Provisional International Civil Aviation Organization and an Honorary Fellow of the Institute.

Several of the principal donors to the New York building of the Institute have held preview receptions for members of their staffs and guests. Typical of these was the reception of Curtiss-Wright Corporation, held on April 16, at which 37 guests were present.

Among the prominent persons present were *(left to right)*: Major Gen. Curtis E. Le May, Deputy Chief of Air Staff for Research and Development, Headquarters, A.A.F.; Gen. Carl Spaatz, Commanding General of the Army Air Forces; Guy Vaughan, President, Curtiss-Wright Corporation; Gen. George C. Kenney, Military Staff Committee, United Nations; and Major Gen. E. M. Powers, Assistant Chief of Air Staff, Matériel and Services, Headquarters, A.A.F.

Other donors who have held receptions are as follows: Grumman Aircraft Engineering Corporation, March 15, 80 guests; Edo Aircraft Corporation, March 29, 60 guests; Fairchild Camera and Instrument Corporation, April 15, 16 guests; Republic Aviation Corporation, April 17, 79 guests; and Fairchild Engine and Airplane Corporation, May 2, 31 guests.

On May 1, Mrs. Bella C. Landauer, who has given many valuable collections to the Institute, held a reception for 75 prominent persons in aeronautics and historical research work.

Additional Duties for Ernest G. Stout

Ernest G. Stout, an Associate Fellow of the Institute, has been named Head of Naval Aircraft Research for his present company, Consolidated Vultee Aircraft Corporation. In addition, he has been appointed a member of the Bureau of Aeronautics Contact Committee of the Navy Industrial Association and reappointed a member of the N.A.C.A. Subcommittee on Seaplanes.

Defense Research Laboratory Formed

The University of Texas has recently established the Defense Research Laboratory, which is one of a series of such organizations in universities and in industry operating under a Section T contract with the Bureau of Ordnance. Fundamental problems relating to certain forms of guided missiles comprise the research goal of the new organization.

Members of the Institute who are staff members of the Defense Research Laboratory include: M. J. Thompson, M. V. Barton, W. A. Meyer, M. H. Clarkson, and Allen M. Poindexter.

Gifts to the Aeronautical Archives

Mr. Otto Praeger, formerly Assistant Postmaster General and the first organizer of the air-mail service in this country, gave two books of rare air-mail clippings. The Republic Aviation Corporation, through the courtesy of Alfred Marchev, gave four framed colored lithographs of the P-47 fighter airplane. The Hotel Roosevelt gave four plates, a bowl, and a cup and saucer, with an airplane design, through the courtesy of Paul Chatelain. An aeronautical plate of 1913 was received from Dr. Eugene F. Du Bois. Howard L. Hartman gave 27 aeronautical pins. A New York Air Show 1946 badge and pass were received from Shepard Dudley.

Dr. Alexander Klemin added books, periodicals, and clippings on air defense, airships, Byrd, Lindbergh, and flight testing to his previous generous gifts. A bound volume of *The Martin Star* was given by The Glenn L. Martin Company. Three Yugoslavian aeronautical books of 1939 were received from Radmio P. Zivkovic of Belgrade. The *New York Sun* gave more than 300 magazines, 100 books, and a carton of clippings, through the courtesy of Robert Mountsier. Professor Maurice Roy sent 18 of his published papers of 1940 to 1946 on aerodynamics, jet propulsion, and gas turbines.

Additional gifts were received from the American Road Builders Association, Dr. Karl Arnstein, Braniff Airways, Inc., California Institute of Technology, Transcontinental and Western Air, Inc., United Air Lines, Inc., and the U.S. Civil Aeronautics Administration, Civil Aeronautics Board, and Civil Service Commission.

Corporate Member Receives Award

Pan American World Airways System, a Corporate Member of the Institute, has been awarded the first Stephens College citation "for outstanding contributions to aviation progress." The award was presented to Samuel F. Pryor, Vice-President of the Pan American company, who accepted for President Juan T. Trippe, at a dinner opening the "Women in Aviation Conference." The citation stated that Pan American was selected for the award "in recognition of notable achievement in aviation and the promotion of world unity through progress in air transportation."

Sections and Branches

Buffalo Section

On March 24 a meeting was held in the Hotel Touraine under the chairmanship of Benson Hamlin. Arthur M. Young, Chief Helicopter Development Engineer, Bell Aircraft Corporation, spoke on the subject "Convertible Helicopter." Mr. Young stated that 6 years ago he realized that the top speed of helicopters, limited to around 100 m.p.h., was too low. An early idea to mitigate this situation was a tandem-rotor helicopter, one rotor of which could be tilted through 90° in flight to serve as a propeller. The inherent difficulties in this scheme were high blade angle requirements and good propeller characteristics of the propulsive rotor, and also the necessity for a gear shift.

Mr. Young's convertible helicopter proposal involves a craft that flies as either a helicopter or an airplane. The salient features of this machine include a pair of two-blade coaxial rotors mounted on the leading edge of a normal wing. As a helicopter, one rotor turns slowly at a high blade angle to provide torque compensation while the other turns rapidly to provide the majority of lift. After rising vertically, the machine will fly as a helicopter until sufficient forward

speed is gained to permit "rolling over" to fly on the wing. In this flight configuration the rotors are revolved at an intermediate speed to serve as propellers. Control in all flight modes is provided only by cyclic pitch variation, while thrust is governed by the usual throttle and collective pitch controls.

The speaker then showed moving pictures of his model test. The model incorporated a single two-bladed rotor with a 5-ft. model wing, powered by a small, electric hand-drill motor. Control was provided through a long, slender dural pole, which, when rotated, operated cyclic pitch through a swash plate, and was further equipped with a trigger and cable to control collective pitch. Power was regulated by a rheostat worn on the operator's chest and connected to the motor by wires inside the pole. Because of this captive operation no indication of stability could be obtained, but general flight characteristics, particularly controllability, were ably demonstrated. Transition from helicopter to airplane and back again was quick and positive, and many flight maneuvers, including loops, were shown in the film.

Mr. Young readily admitted that a multitude of problems are left unsolved, but stated that the idea seems feasible, pending a great deal of additional research.

Los Angeles Section

Members and guests numbering 375 attended a meeting of the Los Angeles Section held on April 11 under the chairmanship of C. L. Johnson. Mr. Johnson announced that the plans for the new Section building had been completed but because of Government building restrictions he was unable to specify the date when construction would begin. He then introduced William H. Dudley, I.A.S. Pacific Coast Executive, who explained the functions performed by his office.

L. E. Root, Program Chairman, opened the technical program, which featured two talks on swept-back airfoils. K. E. Van Every, Assistant Chief of Aerodynamics at the El Segundo Division, Douglas Aircraft Company, Inc., spoke on "Aerodynamic Considerations in Swept-Back Wing Design." J. E. Barfoot, Strength and Test Engineer at the El Segundo Division, Douglas Aircraft Company, Inc., presented "Structural Considerations in Swept-Back Wing Design." In his talk Mr. Van Every placed special emphasis on low-speed flying qualities as affected by the angle of sweepback. Mr. Barfoot followed with his views of the structural aspects, after which the meeting was opened to a discussion period.

Miami Section

On April 24 a meeting was held at the Miami Country Club under the chairmanship of B. C. Stephens, who gave a brief résumé of the activities of the Miami Section since its origin. Members were asked to consider small monthly dues in order to enlarge the Section's activities.

R. S. Bush, Division Meteorologist, Pan American World Airways System, spoke on the subject "Hurricanes." Mr. Bush first gave a historical account of hurricanes from the year 1492 to the present. He stated that the damages resulting from hurricanes are attributable to such factors as steady wind forces, wind gusts, torrential rainfall, high tides, high waves caused by winds, flying objects, and sudden shifting of the transitional path of the eye of the storm. According to the speaker, the factors that control the path of hurricanes are not definitely established. They may for a time follow the normal course and then loop back on themselves and hit the same station twice. Mr. Bush then discussed some famous hurricanes, including the North Atlantic hurricane and the Miami hurricanes of 1935, 1938, and 1945. The speaker stated that wind velocities have been reported in excess of 200 m.p.h. To be classed as a hurricane the wind velocities must exceed 75 m.p.h. High tides in some instances have exceeded 15 ft.

The importance of accurate hurricane reports cannot be overemphasized, particularly in the Florida area, since hurricane winds cause the cancellation of schedules and the moving of aircraft to a safe port. The consequent loss in revenue and the high cost of moving aircraft place the meteorologist in a difficult position, compensated only by the fact that greater loss from damage may be avoided.

New York Section

Two hundred and seventy five members attended a meeting of the New York Section held on April 17 in the McGraw-Hill Building Auditorium under the chairmanship of Jerome Lederer. The speaker was Alexander Kartveli, Vice-President and Chief Engineer, Republic Aviation Corporation, who spoke on the subject "Engineering Aspects of the Development of the Rainbow." He stated that the Rainbow is a commercial adaptation of the XF-12 photographic airplane, which Republic has completed for the U.S. Army Air Matériel Command. Mr. Kartveli traced the steps undertaken in designing the plane to specifications calling for high-altitude, high-speed, and long-range performance. The Rainbow is almost identical to the XF-12 aerodynamically, the only difference being that the forward portion of the Rainbow is 5 ft. longer.

The speaker emphasized the departures from conventional airplane design in his detailed discussion of the wing, fuselage, and landing-gear design. Many of the lessons learned in designing fighter planes were put into practice in the Rainbow, and compromises with the basic determination to obtain greater speeds were few. Mr. Kartveli stressed the use of aerodynamic knowledge in engine-nacelle and airfoil-section design, development of the leading-edge air intake, shape of the fuselage, tail, and control surfaces, control systems, power-plant installation, exhaust-jet thrust arrangement, and structural design. In conclusion, the speaker gave detailed statistics of the performance and cost of operation of the Rainbow. He illustrated the talk with slides and motion pictures of the Rainbow in color.

Philadelphia Section

At a meeting held on April 23 the following Section Officers were elected: Chairman, Ludwig B. Kalinowski, Assistant Chief Engineer, Kellett Aircraft Corporation; Vice-Chairman, Carl De Ganahl, Director of Research, Fleetwings Division, Kaiser Cargo, Inc.; Secretary, Seymour Gottlieb, Aeronautical Engineer, Naval Air Experiment Station, Philadelphia; and Treasurer, Hugh J. Mulvey, Structural Design Engineer, Kellett Aircraft Corporation. The Advisory Committee is composed of the following: Capt. R. S. Barnaby, U.S.N., Francis G. Tatnall, John Rogers, and Dr. Michael Watter.

Carl De Ganahl, Director of Research, Fleetwings Division, Kaiser Cargo, Inc., gave a talk on "The Effect of Temperature and Compression on the Overall Efficiency and Thrust Output of a Gas-Turbine Jet Engine." He presented curves showing the effect of temperature and compression on the overall efficiency and thrust of a jet engine for the ideal case, and various assumed efficiencies for the elements of the engine, such as ram recovery, compressor efficiency, turbine efficiency, and jet-nozzle efficiency. Charles A. Meyer, Thermodynamics Section Engineer, Westinghouse Electric Corporation, discussed the experiences of his company in the design and manufacture of gas-turbine jet engines, concerning the same effects. Mr. De Ganahl and Mr. Meyer served as an "information board" for questions from the members concerning various aspects of jet and rocket propulsion.

San Diego Section

On April 25 a meeting was held in the San Diego Club, at which Smith J. De France, Engineer in Charge, Ames Aeronautical Laboratory, N.A.C.A., spoke on the subject "National Advisory Committee for Aeronautics." Mr. De France emphasized the organization, research facilities, and postwar policies of the N.A.C.A. He gave an account of the functions of the N.A.C.A. and the work being performed by it which served to acquaint those present with the great research facilities at its command.

Services of the Aeronautical Archives of the Institute of the Aeronautical Sciences

The services of the Aeronautical Archives are available to all members of the Institute, to Corporate Members, to advertisers in the AERONAUTICAL ENGINEERING REVIEW and, under usual library limitations, to the public. Four specialized services are available.

The Paul Kollsman Lending Library

This lending library service makes available, *without charge*, the latest and more important aeronautical books.

Members may request the loan of any aeronautical or technical book they wish to borrow. Through an exchange agreement with the Engineering Societies Library, any book on general engineering may be borrowed from its great collection of over 160,000 volumes.

A photostating service is available at usual library rates.

Applications for membership in the library and further information will be sent on request.

The W. A. M. Burden Reference Library

This reference library contains over 12,000 aeronautical books, magazines, pamphlets, and reports gathered from world-wide sources and is one of the most complete aeronautical libraries in the world. Material from this library is not available for loan but may be used for reference purposes at the Aeronautical Archives.

The Pacific Aeronautical Library

6715 Hollywood Boulevard
Hollywood 28, California

Established in cooperation with the aircraft companies the library serves. The leading aircraft companies in or near Los Angeles participate in its support and operation.

This service library for aeronautical research is available to the public for reading privileges. Source material includes aerodynamic and structural research reports, as well as books on drafting, production methods, history, and allied sciences. It furnishes books, periodicals, and pamphlet material to the participating aircraft companies to supplement their engineering libraries.

The Aeronautical Archives Technical Information Service

This service has experienced personnel under the supervision of trained aeronautical engineers to compile any information desired. The services range from listing specialized reference books to the preparation of exhaustive bibliographies, digesting of reports, and general surveys of any aeronautical subject. Some of the available services are:

Bibliographies on any aeronautical subject.
Reports on any aeronautical subject.
Digests of aeronautical books, papers, periodicals, and references.
Translations.
Engineering investigations of special aeronautical subjects.
Biographies of individuals engaged in aeronautics.
Photostats of any aeronautical or general engineering material.
Microfilms made on special order.
Photographs made from the Institute's photographic collection.
Drawings and tracings made.

In addition to the services mentioned any commission which comes within the scope of the Service will be accepted. Special arrangements may be made for work requiring several weeks or months.

Translators are available for accurate transcriptions of all foreign language data. Translations are carefully edited by trained engineers.

Reproductions of any material in the Aeronautical Archives of the Institute may be ordered at standard photostat rates.

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Seattle Section

A meeting held on April 11 featured three talks on the problems in the civil certification of large transport aircraft. Milford F. Vanik, Airworthiness Requirements Engineer, Boeing Aircraft Company, spoke on "History and Philosophy of Aircraft Certification by C.A.A." John B. Fornasero, Project Flight Test Pilot, Boeing Aircraft Company, presented a talk on "Flight Testing for Certification," a description of a flight-test program for certification of large aircraft. Fred E. Woods, Flight Equipment Engineer, Boeing Aircraft Company, spoke about "Flight-Test Instrumentation for Certification," which dealt with the development of special instrumentation and test equipment by Boeing, with demonstrations of some actual instrumentation as used in flight testing. The motion-picture film *Cavalcade of Aviation* was shown.

Washington Section

Major Gen. Howard C. Davidson, Director of the Army Air Forces Aid Society, spoke on the subject "Air Supply for the Campaigns in Burma," at a meeting held on April 3 in the U.S. Chamber of Commerce Auditorium. General Davidson, who formerly commanded the Tenth Air Force, outlined the problems of the Air Transport Command in the China-Burma-India Theater, indicating the air routes that were taken and the reasons for rejecting some apparently shorter ones. He described in detail the method of packaging supplies that were to be parachuted to various points, and gave statistics comparing the tonnage flown by the Air Transport Command in the C.B.I. Theater with that carried on the ground over the Burma and Ledo Roads.

At the conclusion of the talk, motion pictures were shown to illustrate the manner in which various items were packaged for shipment by air, later to be parachuted to earth. These items included radios, ammunition, gasoline, and other delicate or volatile material. General Davidson also exhibited motion pictures showing Razon and Azon bombing.

Academy of Aeronautics

Meetings held on March 4 and March 11 were devoted to discussions of plans for the initiation of new members and their orientation in the functions and services of the Institute.

At a meeting held on March 25, Alphonse Parzel was elected Chairman of the Branch.

Alabama Polytechnic Institute

On April 29 a meeting was held at which J. D. Wade spoke on the subject "Salesmanship—How It Applies to Engineers and Administrative Students." At this meeting new applications for membership were accepted.

Catholic University of America

At a meeting held on April 16, David Rabenhorst, Research Engineer, Johns Hopkins Laboratory of Applied Physics, and an alumnus of the University, delivered a talk on the problems confronting the newly graduated engineer. The films *Unfinished Rainbows* and *Aluminum—Mine to Metal* were shown. Chairman Michael J. Quirk presided.

University of Cincinnati

At a meeting held on April 11 in Baldwin Hall, the following officers were elected: Chairman, Arthur C. Nolte; Vice-Chairman, Fred A. Ebeling; and Secretary-Treasurer, Sydney H. Reiter. Bradley Jones, Faculty Adviser of the Branch, reviewed the functions and awards of the Student Branch.

Georgia School of Technology

At a meeting held on March 21, Denver D. Clark gave a seminar report on aeronautical publications. An outline of the activities for the current term was given. The program consisted of field trips, educational films, establishment of a study room for aeronautical engineering students, and noted speakers to address the Branch on different phases of the industry and new developments in the aeronautical engineering field. Professor Alan Pope, Faculty Adviser, urged all aeronautical engineering students to join the Student Branch.

On April 18 Professor Pope directed a tour through the wind tunnel at Georgia Tech., pointing out details of its construction. The film *Cannon on Wings* was shown.

At the April 25 meeting Rick J. MacDonald gave a seminar report on "Contra-Rotating Propellers." Chairman Charles Green presided.

At a meeting held on April 30, Grover Loening, Adviser to the National Advisory Committee for Aeronautics, spoke on the subject "Helicopter Research and Development." Mr. Loening illustrated his talk with the film *NACA Helicopter Experiments*. The film *Georgia Tech. Helicopter Experiments* also was shown.

University of Illinois

On April 10 a meeting was held at which Prof. R. W. McCloy gave a talk on the subject "N.A.C.A. Power Plants Laboratory." Following Professor McCloy's talk, Norman E. Maxwell, Chairman of the Membership Committee, addressed the Branch members on the desirability of increasing the membership and requested the aid of all those present in the membership drive. The film *Smoke Streams* was shown.

At a meeting held on May 2 in cooperation with the Minerals Industry Society, Dr. Paul Faragher, of the Aluminum Company of America, summarized the development of aluminum alloys in this country and gave a picture of what the aluminum industry has to offer today.

Illinois Institute of Technology

At a meeting held on April 13, the following officers were elected: Chairman, Edward H. Arends; Vice-Chairman, Thomas Feehery; and Secretary-Treasurer, Norman F. Eslinger.

Iowa State College

The following officers were elected at a meeting held on March 7: Chairman, Earl Sorenson; Vice-Chairman, Warren Hayes; Treasurer, James Stephensen; and Secretary, Whit McCormick. The Council Representatives elected were: Edwin H. Hiber and Warren Hayes. J. M. Coan gave an outline of the future for engineering students with some points to be remembered in the education of engineers. Carl N. Sanford is Faculty Adviser.

University of Notre Dame

On March 21 a meeting was held at which the following officers were elected: Chairman, J. J. Atkinson; Secretary, Verne R. Hubka; and Treasurer, William F. Flaherty.

University of Oklahoma

The following officers were elected at a meeting held on April 9: Chairman, Edward H. Ham; Vice-Chairman, Jack Bass; Secretary-Treasurer, Clarren Brandenburgh. Professor Creech, Associate Professor of Mechanics, gave a talk titled "Jet Propulsion." Alvin Petrik is the winner of the Branch Scholarship Award. Donald Malvern is the recipient of the Branch Lecture Award for his paper "Induction Fires."

Purdue University

At a meeting held on March 18 the following officers were elected: Chairman, James B. Sterling; Vice-Chairmen, J. McInstrey and Emmert T. Jansen; Treasurer, Raymond T. Knight; and Secretary, Cameron Donaldson.

At a meeting held on April 2, Dr. Willy Prager was the speaker. His subject was "The Development and Understanding of the Fundamentals of Flight." Dr. Prager traced the momentum theory and applied it in deriving the lift and drag forces. Two hundred members and guests attended the meeting.

Rensselaer Polytechnic Institute

On April 11 a meeting was held at which Richard Frost, Project Engineer and Test Pilot, Bell Aircraft Corporation, spoke on the subject "Developments in Radio Controlled Aircraft." He described the apparatus developed at the Bell company for conducting flight tests by radio control and related some of his experiences in connection with this development. The talk was illustrated with the film *Planes Without Pilots.*

At a meeting held on April 25 the films *V-2 Rocket* and *Me 162 Rocket Fighter* were shown. These are two captured German films showing the V-2 rocket launchings and the take-off and flight of the Me 162.

Spartan College of Aeronautical Engineering

At a meeting held on March 27, Robert H. Perkins was elected Secretary to succeed J. A. Phillips.

A meeting held on April 16 was devoted to a discussion of coming events for the Branch and the amendment of student regulations.

University of Tulsa

At a meeting held on March 14 in the Phillips Engineering Building, Prof. J. C. Klotz spoke on the subject "University of Tulsa Aeronautics Curriculum." The talk was given for the benefit of high-school students who attended this meeting. The films *Aircraft Propellers, Airplane Structures-Control Surfaces,* and *Airplane Structures-Fuselage Construction* were shown. Following the showing of the films a tour was made of the aeronautical laboratories. In addition to a wind-tunnel demonstration, the operation of several testing machines was explained.

On April 11 a meeting was held at which the films *All Work and No Play, Aircraft Engines,* and *Aircraft Structures* were shown. Chairman Adolf E. Kowalski announced the plans for future meetings and discussed the program for the coming year.

Virginia Polytechnic Institute

At a meeting held on April 8, Prof. L. Z. Seltzer welcomed new members of the Branch and gave an orientation talk.

On April 15 the Branch members made an inspection tour of the A.A.F. Air Matériel Command research facilities at Wright Field, Dayton, Ohio. The departments visited by the Branch members included the static-strength testing laboratory; wind tunnels; photographic research department; flight line and engineering and propeller testing laboratories.

At a meeting held on April 22, A. I. Neihouse, Section Head of Spin-Tunnel Research, National Advisory Committee for Aeronautics, Langley Field, Va., spoke on N.A.C.A. activities in general and spin tunnel research in particular. He illustrated his talk with a spin tunnel model of the Douglas TB2D and N.A.C.A. films.

Wayne University

The Student Branch at Wayne University has been reactivated and its first meeting was devoted to a discussion of the constitution and possible amendments.

News of Members

Roy G. Adamson has joined the International Aviation Corporation as Chief Engineer.

Morton Alperin is now a Research Engineer at the California Institute of Technology.

Basil P. Antonenko has become an Aeronautical Engineer in the Educational Service Department of United Air Lines, Inc.

Albert E. Arslan is now a Design Engineer at North American Aviation, Inc.

George P. Baker has become Director of the Office of Transport and Communications Policy in the State Department.

Col. Allan A. Barrie has joined the consulting firm of Alvin P. Adams Associates.

Rex B. Beisel, General Manager of the ChanceVought Aircraft Division of United Aircraft Corporation, has been elected Vice-President of that company.

Milton C. Bergey is now a Senior Design Engineer in the Fairchild Engine and Airplane Corporation.

Morgan McC. Blair has joined the Globe Aircraft Corporation as Chief of Aerodynamics and Experimental Flight Test.

Philip N. Bright is now a Senior Design Engineer in the Allison Division of General Motors Corporation.

John S. Brown has become Vice-President of Brownair, Inc.

Harry A. Burke is studying Industrial Engineering at New York University.

Col. Paul A. Campbell is now engaged in aero medical research at the University of Illinois.

Thomas H. Carson has joined the Division of Industrial Cooperation of Massachusetts Institute of Technology.

George F. Chapline, formerly Vice-President and a Director of Wright Aeronautical Corporation and a Captain in the Navy during the war, has become Assistant General Manager of the Ranger Aircraft Engines Division of Fairchild Engine and Airplane Corporation.

Hermon H. Cole, Jr., has joined McDonnell Aircraft Corporation as an A-Layout Engineer, Design Proposal Group.

Charles H. Colvin, Past President of the Institute, has been elected a Director of the Kidde Manufacturing Company, Inc., and of the Bloomfield Tool Corporation.

Robert E. DeLand is now a Stress Analyst "A" at North American Aviation, Inc.

Frank W. Devlin is Program Planning Officer of the Civil Aeronautics Administration.

I. Charles Dickens has joined North American Aviation, Inc., as a Stress Analyst.

A. Milton Drummer is now a Stress Analyst at Republic Aviation Corporation.

Edward P. Eales is now at Iowa State College as a Student and Instructor.

Roger D. Elliot is now an Aerodynamicist with the Northrop-Hendy Company.

Jack H. Friedman has joined American Central Manufacturing Corporation as an Engineer.

Reginald E. Gillmor, President of the Sperry Gyroscope Company, Inc., and Vice-President of Sperry Corporation, has been elected to the Board of Trustees of Barnard College.

Marcel I. Gould has joined the Engineering Design Office of Canadair, Limited, as Wing Group Leader.

Arthur Graham is now an Aerodynamicist at Douglas Aircraft Company, Inc.

William A. C. Greene has joined the Provisional International Civil Aviation Organization as Airworthiness Expert.

Ralph D. Hampton is now a Design Engineer at Northrop Aircraft, Inc.

Harold V. Hawkins has become Chief Electronics Engineer at Bell Aircraft Corporation.

Fred W. Herman has been appointed Plant Manager of Douglas Aircraft Company's Long Beach plant.

Robert L. Hildebran has joined the U.S. Plywood Corporation as Administrative Engineer.

Robert A. Hitch is now a Thermodynamicist in the Aircraft Gas Turbine Division of De Laval Steam Turbine Company.

Harry E. Hjorth has joined Douglas Aircraft Company, Inc., as Assistant Chief Power Plant Engineer.

Willard A. Hoffman has become Vice-President of the Command Aircraft Corporation.

William V. Holden has joined Trans-Canada Airlines as a Junior Engineer.

George H. Hufferd has been elected Engineering Vice-President of the Weatherhead Company.

Lester B. Hutchinson, formerly Chief of Laboratories at Brewster Aeronautical Corporation and later Assistant Chief Engineer at Elco Naval Division of Electric Boat Company, is now Head of the Experimental Structures Section of the Structures Branch, Bureau of Aeronautics, Navy Department.

Thomas C. Kavanagh is now an Instructor in Civil Engineering at New York University.

Robert E. Kennedy has joined the Stavis Oil Company as Sales Engineer.

Charles M. Kicherer is now an Engineer at Republic Aviation Corporation.

James H. Kindelberger, President and General Manager of North American Avia-

tion, Inc., has been elected a Director of the Air Power League.

Lewis Kirchler has joined the Pullman Standard Car Manufacturing Company as a Draftsman.

Kazimierz Korsak is now Chief Engineer of Northwest Industries Limited (Canada).

Bruce R. Lane has joined the Bay Products Corporation as a Designer.

Donald C. Larson is now a Research Assistant with the Ordnance Research Laboratory at Pennsylvania State College.

James P. Layton has joined The Glenn L. Martin Company as a Research and Development Engineer.

William C. Lazarus has been appointed Florida State Aviation Supervisor.

Milton I. Levine is now an Executive of the Mil-An Manufacturing Corporation.

Robert L. Lichten has joined Kellett Aircraft Corporation as an Aerodynamicist.

Harlowe J. Longfelder is now an Aerodynamics Engineer at Lockheed Aircraft Corporation.

John McC. Maxwell has joined Douglas Aircraft Company, Inc., as an Engineer.

Comdr. Neil MacCoull has returned from nearly 3 years of active duty with the U.S. Navy to rejoin the Beacon Laboratories of The Texas Company as Consulting Engineer.

Charles J. McCarthy, Vice-President of United Aircraft Corporation, has been appointed to the Executive Committee of the Air Transport Division of the American Society of Civil Engineers.

Alexander J. McCulloch has joined the Structures Development Section of Chance Vought Aircraft Division of United Aircraft Corporation.

Brian D. McDonough is now with the Engineering Department of Boeing Aircraft Company.

Andrew R. McNaughton has become President of Norcan Limited (Canada).

Russell E. McWhirter has joined McDonnell Aircraft Corporation as an Aeronautical Engineer.

John H. Millie is now Project Engineer with A. V. Roe & Company, Limited (Canada).

George J. Mullaney has enrolled at Rensselaer Polytechnic Institute to do graduate work.

Redford H. Mulock has become Assistant Executive Vice-President at Canadian Car & Foundry Company Limited (Canada).

Alexander R. Norris has joined Republic Aviation Corporation as Senior Structures Engineer.

Eric Olsen has become Manager of the Aviation Division of the Wayne Pump Company.

William B. O'Neal is now Chief of the Power Plant Design Section of The Glenn L. Martin Company.

John J. Palermo has entered the U.S. Army Air Forces.

Thracy Petrides is now an Engineer at Federal Telecommunications Laboratories, Inc.

William I. Phemister has joined A. V. Roe & Company, Limited (Canada), as Loft Supervisor.

Benham S. Pond is now a Consulting Engineer at the National Bronze & Aluminum Foundry Company.

George F. Chapline, who has been appointed Assistant General Manager of the Ranger Aircraft Engines Division of Fairchild Engine & Airplane Corporation.

Irving Rappaport has joined the Wright Aeronautical Corporation as a Test Engineer.

Blake Reynolds is now a Technical Assistant at Texaco Development Corporation.

Paul E. Richter, Executive Vice-President of Transcontinental and Western Air, Inc., has been elected a Vice-President of the Conquistadores del Cielo.

James C. Riple, Jr., has joined McCulloch Aviation, Inc., as a Draftsman.

Clifford E. Roberts has been appointed Washington, D.C., Representative, Engineering and Sales, for the Boeing Aircraft Company.

William H. Roberts has rejoined North American Aviation, Inc., as an Aerodynamicist in the Vibration and Flutter Group.

John C. Rollo has become Project Engineer, Repair and Conversions Project, at Canadair Limited (Canada).

Reinhardt M. Rosenberg has joined the faculty of Purdue University as an Instructor.

Raymond I. Schneyer is now a Research Assistant at the University of Michigan.

William U. Shaw has joined A. V. Roe & Company, Limited (Canada), as an Assistant Designer.

Herbert Shieber is now a Test Engineer at McDonnell Aircraft Corporation.

Louis H. Shornick has been commissioned a Lieutenant (j.g.) in the U.S.N.R.

Carl B. Squier, Vice-President of Lockheed Aircraft Corporation, has been elected a Vice-President of the Conquistadores del Cielo.

Jerome Steffens has joined the faculty of Villanova College as Instructor of Engineering.

Thomas M. Sullivan has become Assistant Director of Field and Installation Engineering at Ranger Aircraft Engines Division of Fairchild Engine and Airplane Corporation.

Lt. Col. Trond A. Sundem has joined Eastern Air Lines, Inc., as Manager of the Agency Department.

James A. Thomas is now a Surveyor in the firm of H. R. Becker.

David W. Thurlow has joined Douglas Aircraft Company, Inc., as a Stress Analyst "A."

Frederic E. Titus is now a Senior Engineer at Trans-Canada Air Lines.

Milford F. Vanik has joined Boeing Aircraft Company as Airworthiness Requirements Engineer.

Charles F. von Herrmann, Jr., is the owner of the Turkey Creek Manufacturing Company.

Willis L. Wells has become President of the firm of Geo. E. Wells, Inc.

Vernon D. Westfall is now an Engineering Test Pilot at the Hartzell Propeller Company.

John A. Wilson has become a Director of Trans-Canada Air Lines.

Warren G. Yoder has joined Republic Aviation Corporation as a Stress Analyst.

Members Elected

The following applicants for membership or applicants for change of previous grades have been admitted since the publication of the list in the last issue of the REVIEW.

Transferred to Associate Fellow Grade

Bricker, Ethelbert Irvin, B.M.E., M.S. in Ae.E.; Asst. Prof., Georgia School of Technology.

Ciffrin, Assaf, D.Sc., M.S., D.I.C. (Ae.); Sr. Research Engineer, New York University.

Francis, Thomas F., B.S. in Ae.E.

Gladwin, Harold Sterling, Jr., Power Plant Development Engineer, Boeing Aircraft Co.

Elected to MEMBER Grade

Allison, John McComb, B.S. in M.E.; Comdr., Bureau of Aeronautics, U.S. Navy Dept.

Arentson, Richard Eugene, Ae.E.; Layout Designer, The Glenn L. Martin Co.

Ariessohn, Arthur M., M.A.; Asst. Project Engineer, Edo Aircraft Corp.

Badenoch, Benjamin Wilson, B.S.; Consultant—Aircraft & Design Consultation, Badenoch Associates.

Baumgarten, Edgar Otto, Asst. Project Engineer, The Ryan Aeronautical Co.

Beardsley, Melville Whitnel, M.S. in M.E.; Major, Airplane Project Officer, U.S. Army Air Forces.

Conner, Charles Herman, B.S. in Bus. Admin.; Meteorological Consultant, T. & W. A., Inc.

Cooper, Benjamin, B.S.; Proprietor, Taller and Cooper.

Crim, Henry Cecil, Aircraft Maintenance Engineering Supervisor, Air Technical Service Command (Wright Field).

Dippenworth, John Charles, B.S.; Checker, The Glenn L. Martin Co.

I.A.S.

National Meeting Schedule

Annual Summer Meeting

July 18–19, 1946

Los Angeles, Calif. Royce Hall, U.C.L.A.

Air Transport Meeting

October 24, 1946

Washington, D.C. Hotel Statler

Tenth Wright Brothers Lecture

December 17, 1946

New York, N.Y. (Location to be announced)

Fifteenth Annual Meeting

January 28–29–30, 1947

New York, N.Y. (Location to be announced)

The Meetings Committee of the Institute invites participation in the technical sessions of the Air Transport and Fifteenth Annual meetings of the Institute. The program of the Annual Summer Meeting is in process of completion and additional papers cannot be considered.

Members or organizations wishing to submit papers for these Meetings should send complete papers, or outlines or summaries, to the Meetings Committee at least three months prior to the meeting at which it is proposed to present the paper. Outlines or summaries should not exceed 1,000 words.

All papers submitted will be considered for publication in the *Journal of the Aeronautical Sciences* or the *Aeronautical Engineering Review*.

All correspondence should be addressed to

The Meetings Committee

Institute of the Aeronautical Sciences

2 East 64th Street

New York 21, N.Y.

Emmons, Paul Clyde, M.E.; Chief Aerodynamicist, Bell Aircraft Corp.

French, Gerthal, Mgr., Product Research and Development, Richfield Oil Corp.

Gandhi, Natvarlal Nathalal, Executive Supervisor, Production Mfg. Dept., Hindustan Aircraft Limited (India).

Glasgow, Charles Steward, Jr., M.E.; Asst. Design Engineer, Douglas Aircraft Co., Inc.

Greenly, Kenneth Howard, B.Sc.; Project Engineer, D. Napier & Son Ltd. (England).

Hauser, George Henry, B.S.M.E.; Vice-President, Liberty Aircraft Products Corp.

Hawkins, Jack Donald, Assoc. of Arts; Design Group Supervisor, Lockheed Aircraft Corp.

Kelley, Bartram, A.M.; Helicopter Development Engineer, Bell Aircraft Corp.

Kerr, Cecil Edwin, B.Sc.; Sr. Scientific Officer, British Supply and Air Commission.

MacLean, Edward Archibald, M.S.; Rose Polytechnic Institute.

Marshall, Charles Henry, B.Ae.E.; Chief Design Engineer, Curtiss-Wright Corp.

Marvin, Philip Roger, B.S. in Engineering; Director of Research and Development Engineering, Milwaukee Gas Specialty Co.

Minassian, Bartive, B.S. in M.E.; Engineer, Boeing Aircraft Co.

Monroe, Louis Lloyd, B.S.; Chief Supersonic Wind Tunnel Branch, Aircraft Engine Research Lab., N.A.C.A.

Newbold, Fitz Eugene, Jr., B.S. in Engineering; West Coast Representative, Ranger Aircraft Engines Div., Fairchild Engine and Airplane Corp.

Ogness, Arthur Melvin, Stress Analyst A., Douglas Aircraft Co., Inc.

Orr, John Lewis, B.A.Sc.; Head of Low Temperature Section, Aero. Lab., National Research Council (Canada).

Osdin, Charles, B.S. in E.E.; Engineer, Lark Div., Fairchild Engine and Airplane Corp.

Previs, Nicholas John, Designer—Mech. Controls, Douglas Aircraft Co., Inc.

Redding, Edward Macarthur, Sc.D.; Asst. Head—Technical Research Lab., North American Aviation, Inc.

Reichers, Louis Theodore, Owner (Aircraft Manufacturer), own business.

Schroeder, Henry Alfred, M.D.; Medical Member, U.S.N.R.

Shapiro, Ascher H., S.B.; Asst. Prof. of Mech. Eng., Mass. Inst. of Technology.

Simpson, Edward Hattrem, Chief Engineer, Pettit Engineering Company.

Stratford, Alan Howard, B.Sc.; Aeronautical Technical Asst., D. Napier & Son, Ltd. (England).

Talbert, Turley Wynne, Engineering Personnel Manager, Douglas Aircraft Co., Inc.

Vaughn, Raymond Eugene, B.S. in M.E.; Hydraulics Engineer, The Glenn L. Martin Co.

Winzer, Frederick Arnold, Jr., B.S.; Installation Engineer, Propeller Div., Curtiss-Wright Corp.

Transferred to MEMBER Grade

Chen, Ou-Wen Winston, B.Ae.E.; Flight Test Engineer, Republic Aviation Corp.

Mashman, Joseph, C.E.; Asst. Chief of Flight Test Dept. (Helicopter Div.), Bell Aircraft Corp.

Payne, Louis Amos, Ae.E.; Post Graduate Student, Mass. Inst. of Technology.

Schuette, Evan Henry, B.S.; Aero. Engineer, Langley Mem. Aero. Lab., N.A.C.A.

Schunter, Hollis Harold, Meteorologist, Pan American Airways System.

Smith, Alvin Carl, B.S. in Ae.E.; Power Plant Design Engineer, Curtiss-Wright Corp.

Sturm, Fred, Asst. Chief Engineer, Winner Mfg. Co.

Elected to Industrial Member Grade

Parsons, John Thorén, President, Parsons Industries.

Sharp, Edward Raymond, Manager, Aircraft Engine Research Lab., N.A.C.A.

Elected to Technical Member Grade

Baird, Eugene Frederick, B.M.E.; Structural Research Engineer, Grumman Aircraft Engineering Corp.

Budiansky, Bernard, B.C.E.; Structural Engineer, Langley Mem. Aero. Lab., N.A.C.A.

Cofiniotis, Otis James, Structural Designer, Edo Aircraft Corp.

Crook, Norman LeRoy, Lead Engineer—Aerodynamicist, Boeing Aircraft Co.

Froehlich, Jack Edward, Student, Calif. Institute of Technology.

Hiller, Stanley, Jr., General Manager, United Helicopters Inc.

Lewis, Ethel Lorene, B.S. in Physics; Analytical Engineer, Platt-LePage Aircraft Co.

McDonough, John Lawrence, Designer, Canadair Ltd. (Canada).

Mitchell, Frederick Paige, B.S. in Ae.E.; Stress Engineer, Canadian Car & Foundry (Canada).

Nistál, Gerard E., Editor, Air Power Div., Technical Consultant, Air Age, Inc.

Porter, James Irwin, B.C.E.; Jr. Engineer and Draftsman, Marshall & Gongwer.

Ryan, Francis Anthony, B.S. in Ae.E.; Hydraulic Engineer, Canadair Ltd. (Canada).

Whitney, Joseph Herbert, Jr., Lt., Squadron Radar Navigator, U.S. Army Air Forces.

Transferred from Student to Technical Member

Bradfield, Walter Samuel, Ae.E.; Engineer (Aeronautical), The Applied Physics Lab., The Johns Hopkins Univ.

Brill, Murray.

Clarke, William Denleigh, B.Ae.E.; Ensign, U.S.N.R.

Cummings, John Bissett, B.Ae.E.; Engineering Draftsman, The Glenn L. Martin Co.

Gillespie, Robert Webster, B.S. in Ae.E.; Lt. (j.g.), Engineering Officer, Bur. of Aeronautics, U.S. Navy Dept.

Hannan, Paul Jerome, B.S. in M.E.; Aviation Mechanic, U.S. Navy.

Heinke, Harry Shelton, Jr., Ae.E.; Ensign, U.S.N.R.

Hess, Robert William, B.S. in Ae.E.; Bureau of Aeronautics Resident Representative, North American Aviation, Inc.

Holodnik, Edward, B.S.; Ensign, U.S.N.R.

Justen, John Joseph, B.Ae.E.; Detail Engineer—Project, Boeing Aircraft Co.

Kunz, Robert Eugene, B.S.; Ensign, U.S. Navy.

Mack, Leslie M., U.S. Navy.

Moore, Roy Gredy, B.Ae.E.; Ensign, U.S. Navy.

Muñoz, Adolfo Luis, Ae.E.

Orr, Robert Gordon, B.S.; Ensign, U.S. Navy.

Richardson, Ned West, B.Ae.E.; Aerodynamicist, Chance Vought Aircraft Div., United Aircraft Corp.

Titus, Jules Richard, B.Ae.E.; Ensign—Asst. Assembly Officer, Assembly & Repair Dept., U.S. Navy.

Turner, Robert Fogle, B.S. in Ae.E.; Douglas Aircraft Co., Inc.

Necrology

Livio Anthony DeBin

Livio Anthony DeBin, a Technical Member of the Institute, was killed in action in Germany on April 12, 1945, while in the service of the United States Army. News of his death has only recently reached the Institute.

Born in Italy on July 6, 1921, Mr. DeBin moved to Ontario, Canada, where he attended Patterson Collegiate Institute from 1934 to 1939, receiving junior and senior matriculation diplomas. From 1939 to 1943, he was enrolled in the aeronautics course at the College of Engineering of the University of Detroit.

From June to September, 1941, he was employed as a Draftsman at the Rolls-Royce Division of Packard Motor Car Company, where he was engaged in the redesigning of parts in the tooling of the Merlin engine. In September, 1941, he joined Fleet Aircraft, Limited, of Fort Erie, Ontario, Canada, as a Senior Draftsman, advancing successively to Layout Draftsman, Checker, Assistant Group Leader, Supervisor, and Liaison Engineer.

Personnel Opportunities

This column is for the use of individual members of the Institute seeking new connections and organizations offering employment to aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute.

WANTED

Aerodynamicists—Immediate work is available for three qualified engineers with Fleetwings Division of Kaiser Cargo, Inc. First man must be a stability and control specialist with at least 2 years' experience, some experience with problems related to flight at transonic and supersonic speed. Second man must be a specialist in aircraft performance estimation with a minimum of 2 years' experience, familiar with compressibility phenomena and with means of accounting for these phenomena in performance estimation. Third man must be familiar with general aerodynamics work and possess some knowledge of the characteristics of ram jet, pulse jet, and rocket jet engines. Good background in thermodynamics is necessary. Address reply to G. G. Cudhea, Chief Engineer, Kaiser Cargo, Inc., Fleetwings Division, Bristol, Pa.

Aeronautical Engineers—Thoroughly experienced and qualified to deal with problems in aerodynamics and thermodynamics. Opportunity to participate in development work arising from the application of advanced types of power units and the high-speed performance resulting. Write, giving education and experience, to the Engineering Department, Consolidated Vultee Aircraft Corporation, Vultee Field Division, 842 S. Lakewood Blvd., Downey, Calif.

Transmission Engineer—Long-established aircraft manufacturer engaged in helicopter development requires services of mechanical designer on gear transmission work. In staff specialist capacity, position offers unusual opportunities. Aircraft experience desirable but not required. Kellett Aircraft Corporation, North Wales (Philadelphia), Pa.

Assistant Professor—To teach applied mechanics, strength of materials, and fluid mechanics. A young man with M.S. degree preferred. Applicant should have special qualifications in the field of hydraulics and fluid mechanics. Opportunity to work in fluid meters research and the development of a fluid mechanics laboratory. Address inquiries to Department of

Mechanics, University of Oklahoma, Norman, Okla.

Detail and Layout Engineers, Stress Analyst—For design and development of new aircraft in Engineering Division. Write to Chief Administrative Engineer, Boeing Airplane Company, Wichita, Kan., for additional information.

Aeronautical Engineers—The U.S. Naval Air Station, Quonset Point, R.I., is accepting applications of highly qualified aeronautical engineers for future positions. Salary range from $2,320 to $5,180 per annum. Applicants may obtain Civil Service Application Form 57 from local post office. Forward applications, completely filled out to the Recorder, Labor Board, U.S. Naval Air Station, Quonset Point, R.I.

Instructor in Aeronautical Engineering—To teach courses in general aeronautics and stress sections. Must have aeronautical engineering degree. Opportunity to do graduate work. Appointment for September 15, 1946. Address: Department of Aeronautical Engineering, University of Minnesota, Minneapolis, Minn.

Assistant or Associate Professor—To conduct senior and graduate courses in airplane stress and design group. Must have M.S. degree in Aeronautical Engineering and experience in industry or teaching. Appointment for September 15, 1946. Salary open. Address: Department of Aeronautical Engineering,. University of Minnesota, Minneapolis, Minn.

Aerodynamicists—College graduates with sound theoretical training and at least 1 year of graduate study in compressible subsonic flow and supersonic flow to do research and test work in the Supersonic Wind Tunnel of the Ballistic Research Laboratories, Aberdeen Proving Ground, Maryland. This is by far the largest operating supersonic wind tunnel in the country. Remuneration in accordance with qualifications. Write, giving education and experience, to The Commanding General, Aberdeen Proving Ground, Maryland, Attention: Director, Ballistic Research Laboratories.

Technical Representatives—To perform industrial representation within their resident state, county, or city for manufacturers and associated concerns throughout the country. Must have permanent position with an established company and complete domestic and technical information. Address inquiries to George E. Harris Associates, Rooms 314–318, Administrative Building, Municipal Airport, Wichita, Kan., Attention: G. E. Harris.

Design Engineers, Stress Analysts, Layout and Draftsmen—Needed for development work on experimental military aircraft, as well as production engineering. Address inquiries to Curtiss-Wright Corporation, Airplane Division, Columbus 16, Ohio. Attention: R. C. Blaylock, Chief Engineer.

Research Engineer—Theoretical Aerodynamicist or Thermodynamicist with advanced degree to engage in research on certain high-speed developments. For details write Box 1-T, Richmond 2, Va.

Design Engineers; Draftsmen—Opportunities now exist for qualified design engineers and draftsmen for work on the new stratocruiser C-97 military transport and other new developments. Here is an opportunity to become associated with one of the world's leaders in aircraft design and production and to participate in the design of the aircraft of tomorrow. Write to the Engineering Department, Boeing Aircraft Company, Seattle 14, Wash.

Aerodynamicists and Thermodynamicists—Research minded and with good theoretical background, to engage in research work on high-speed and jet propulsion developments, advanced degrees preferred. Salary commensurate to qualifications. Replies will be held in strict confidence. Write, giving education and experience, to Cornell Aeronautical Laboratory, Buffalo 5, N.Y.

Aeronautical Engineering Professor to teach Airplane Design, Airplane Structure, and related subjects. Applicants required to have a degree in aeronautical engineering as well as practical experience in the field. Preference given to candidates having advanced degrees. Facilities now under construction and plans for future construction will provide ample opportunity for research, development, and consultation. Rank and salary will depend upon training and experience of applicant. In applying please give brief sketch of personal qualifications, education, and experience. Address reply to Prof. Robert M. Pinkerton, Department of Aeronautical Engineering, A. & M. College of Texas, College Station, Texas.

Aircraft Engineers—Immediate, permanent openings for aircraft engineers with 5 years' experience in aerodynamics, structural design, and C.A.A. airworthiness requirements with Southern California aircraft manufacturer. Air-mail qualifications and recent photo to P.O. Box 29, Burbank, Calif.

Radio, Electronic and Telephone Engineers, Electronic and Mechanical Draftsmen—One of the largest manufacturers of a wide variety of electronic and communications equipment in the world is fully prepared and ready with an ambitious postwar program. Write to Personnel Manager, Federal Telephone & Radio Corp., 591 Broad Street, Newark, N.J.

Aircraft Stress Engineers thoroughly familiar with the analysis of aircraft structures, aircraft controls, and all component parts for work on helicopters. Excellent opportunities for personnel interested in rotary-wing aircraft. Apply by letter, giving references, to Administrative Engineer, Kellett Aircraft Corporation, Plant #2, Lansdowne Avenue above State Road, Upper Darby, Pa.

Personnel Needed—Executive and Administrative experience in manufacture of aircraft. Positions available in several fields: Factory and Production Management, Matériel, Tooling and Engineering. McDonnell Aircraft Corporation, Ambassador Building, St. Louis 1, Mo.

Aeronautical Engineers—For immediate work, the long-established Aeronca Aircraft Corporation seeks project engineers, design engineers, weight engineers, and layout draftsmen. These positions offer unusual permanent opportunities with the pioneer light-plane company of America for qualified men. Write in complete detail to Aeronca Aircraft Corporation, Box 00, Middletown, Ohio.

Aeronautical Engineer—Position open in Washington, D.C., for aerodynamicist with design and research experience in stability and control and high-speed aerodynamics. Salary between $4,300 and $5,180 per year. In applying please give brief sketch of personal qualifications, education, and experience. Address inquiries to Box 526, Institute of the Aeronautical Sciences.

Power-Plant Design Engineer—For supervision of design of power-plant installations. Will also supervise design of mechanical equipment, including heating and ventilating equipment, hydraulic, vacuum, and oxygen systems and cabin supercharging systems in airplanes. Must have mechanical or aeronautical engineering degree with over 7 years' experience in this work in aircraft industry. Position available in Midwest airplane company. Address inquiries to Box 518, Institute of the Aeronautical Sciences.

Mechanical or Aeronautical Engineer—Graduate with several years' experience in conducting aircraft-engine tests, for research assistant in engine laboratory of Eastern university. Position permits applicant to carry part-time graduate work; may lead to teaching affiliation. Salary commensurate with ability and experience. Address inquiries to Box 516, Institute of the Aeronautical Sciences.

Assistant Professor of Aeronautical Engineering—To teach courses in aircraft design and aircraft structures in aeronautical engineering department of large university in Southwest. Op-

portunities for research in structures and in newly organized Navy Ordnance program provide for full year-round employment. Applicants should submit detailed record of education and experience. Address inquiries to Box 512, Institute of the Aeronautical Sciences.

Aeronautical Engineers—To teach mathematics, primary and advanced aeronautical engineering subjects including design and stress analysis in a Midwestern university. Address inquiries to Box 511, Institute of the Aeronautical Sciences.

Project Engineer, Chief of Structures—Excellent opportunity for qualified men with a manufacturer of medium sized aircraft. Commercial experience preferred but not necessary. Address inquiries to Box 498, Institute of the Aeronautical Sciences.

Assistant or Associate Professor—Sought by Aeronautics Department of Engineering College to teach undergraduate and graduate courses in aerodynamics, aircraft structures, or aircraft propulsion. Must have good academic training and teaching experience; constructive interest in aeronautical research and development, preferably industrial or laboratory experience in this field. Starting salary range: $3,000 to $5,000, depending upon qualifications. Address inquiries to Box 490, Institute of the Aeronautical Sciences.

Instructor—In department of mechanical engineering to teach mainly aerodynamics, aeronautical design, and develop aeronautical laboratory. Advanced degree desired. Appointment April or September as Instructor or Assistant Professor, dependent on qualifications. Location Philadelphia. Address inquiries to Box 477, Institute of the Aeronautical Sciences.

Design Draftsmen—To prepare working plans and detail drawings of new or improved products, sketching from engineering notes; checking designs for engineering accuracy; supervising some Detail Draftsmen who may be assisting. At least 5 years' experience required. Salary of $50 to $70 for 40-hour week, time and one-half for any overtime. Address inquiries to Box 476, Institute of the Aeronautical Sciences.

Aeronautical Engineers—Prominent light-plane manufacturer located in New York area seeking qualified aeronautical engineers including aerodynamicists, stress analysts, loftsmen and draftsmen, particularly those experienced in molded plywood and sheet metal structures. Military and civil contracts. Address inquiries to Box 466, Institute of the Aeronautical Sciences.

Assistant Chief Aircraft Designer—Good background and experience in civil aircraft and conversant with C.A.A. requirements. Permanent position with aircraft manufacturer in Central Eastern Coast area. Reply by letter giving particulars as to experience, salary desired, and date available. Address inquiries to Box 463, Institute of the Aeronautical Sciences.

Chief Stressman with C.A.A. requirements experience, and **One or Two Assistants,** to take charge new project. Permanent position with aircraft manufacturing firm on middle eastern coast. Reply stating full particulars of past experience, salary required, and when free to take up a new position. Address inquiries to Box 462, Institute of the Aeronautical Sciences.

Layout and Detail Draftsmen, Senior and Junior—Required for progressive aircraft program with aircraft manufacturing firm on middle eastern coast. Reply stating full particulars of past experience, salary required, and when free to take up a new position. Address inquiries to Box 461, Institute of the Aeronautical Sciences.

Aircraft Design Engineers—Immediate permanent openings for design engineers with good experience in aerodynamics, structural design and C.A.A. airworthiness requirements with aircraft manufacturing firm on middle eastern coast. Reply stating full particulars of past experience, salary required, and when free to take up a new position. Address inquiries to Box 460, Institute of the Aeronautical Sciences.

Designing Draftsman—Design ignition components of electronic and electromechanical nature. Also do follow-up on experimental orders. Should be conversant with design for low-cost production. Starting salary of $70 to $85 for 40-hour week; time and one-half for any overtime. Address inquiries to Box 458, Institute of the Aeronautical Sciences.

Assistant Engineer—Design work, test work, test analysis, and creative development work in high-frequency ignition and electrical test equipment program. Must have experience in modern electronic design, test and development methods. Starting salary of $4,200 to $4,800. Address inquiries to Box 456, Institute of the Aeronautical Sciences.

Aeronautical Engineers—Immediate positions open in Washington, D.C., for aircraft engineers with practical experience in structural design and research. Salary between $3,640–$5,180 per year. In applying please give brief sketch of personal qualifications, education, and experience. Address inquiries to Box 448, Institute of the Aeronautical Sciences.

Stress Analyst—Engineer with experience in design of rotary wing aircraft rotor blades. Must have thorough knowledge of rotor blade stress and aerodynamic analysis procedure, experimental procedure for determination of static and dynamic stresses and fatigue research methods. Permanent position involving study of wood, metal, and plastic blades. Address inquiries to Box 443, Institute of the Aeronautical Sciences.

Assistant Professor of Aeronautical Engineering—Must have experience in structural analysis and design. Permanent position. Applicants should furnish details describing education, experience, and personal data. College located in Virginia. Address inquiries to Box 442, Institute of the Aeronautical Sciences.

Assistant Professor—To conduct senior and graduate courses, develop laboratory, and direct research in aircraft power plants, with emphasis on standard aircraft engines and accessories. Advanced degree preferred. Position with an established aeronautical engineering department of a large eastern university. Appointment September, 1946. Salary open. Address inquiries to Box 434, Institute of the Aeronautical Sciences.

Aircraft Layout Draftsmen—Familiar with layout and design of aircraft sheet metal structures, controls, mechanisms, power plant, electrical systems and equipment. Excellent opportunities for experienced personnel interested in helicopter design. Address inquiries to Box 414, Institute of the Aeronautical Sciences.

Assistant or Associate Professor—To conduct undergraduate and graduate work in theory, design, and research in propellers and jet and rocket propulsion systems. Applicant should have at least one graduate degree and a sound theoretic and applied background in the thermodynamics and aerodynamics of propulsion systems. Large Midwestern University. Address inquiries to Box 413, Institute of the Aeronautical Sciences.

Project Engineer—Experienced and talented design man to undertake the responsibility for a new aircraft project from inception to completion. Plant located on eastern seaboard. Salary scale above average. Write full particulars. Address inquiries to Box 370, Institute of the Aeronautical Sciences.

Works Manager—Manufacturing executive to set up and operate a production program on a new aircraft. Will direct Manufacturing, Facilities, Inspection and Procurement Departments. Salary scale above average. Located on eastern seaboard. Write full particulars. Address inquiries to Box 369, Institute of the Aeronautical Sciences.

Airplane Salesmen—Large established producer of personal aircraft seeking several qualified airplane salesmen with both flying and merchandising experience. Interview in New York. Address inquiries to Box 362, Institute of the Aeronautical Sciences.

Associate Professor of Aircraft Structures—To teach senior and graduate courses in aircraft structural theory, develop structures laboratory, and direct graduate structural research work. Practical experience necessary. Advanced degrees preferred. Permanent position. Leading State University. Location—Midwest. Address inquiries to Box 340, Institute of the Aeronautical Sciences.

Associate or Full Professor: To teach advanced courses and direct research in the Aircraft Power Plant Design field. Recent experience in turbine and jet engine design and testing necessary. Advanced degrees preferred. Permanent position, large mid-western university. Can wait six months if necessary. Address inquiries to Box 339, Institute of the Aeronautical Sciences.

Assistant or Associate Professor of Aerodynamics—Young man with Ph.D. to teach graduate courses in theoretical aerodynamics and direct theoretical and experimental research in this field. Research experience necessary. Position permanent. Mid-western State University. Address inquiries to Box 338, Institute of the Aeronautical Sciences.

Associate or Professor of Aerodynamics—To teach performance, control, stability and develop correlating flight test and flight instrumentation courses for large mid-western university. Position permanent. Practical experience necessary. Advanced degrees preferred. Address inquiries to Box 337, Institute of the Aeronautical Sciences.

Patent Engineer—Familiar with patent disclosures and procedures. Essential helicopter industry. Salary commensurate with experience and present earning capacity. Address inquiries to Box 322, Institute of the Aeronautical Sciences.

Assistant Professor—To teach Mechanics, Strength of Materials, and Physics in a small Mid-western College. Must have Master of Science Degree, preferably in Engineering or Physics. Salary dependent on qualifications and experience. Position permanent. Address inquiries to Box 291, Institute of the Aeronautical Sciences.

AVAILABLE

Engineer—B.S. in M.E., Ae.E.; desires responsible executive position, preferably with personal plane manufacturer. Has 20 years' design, production, and executive experience which merited brief biography in *Who's Who in America*. Address inquiries to P.O. Box 503, Mt. Vernon, N.Y.

Engineer—E.E.; Executive or Administrative. Thirty-one years old. Ten years' experience electronics, servos, aircraft and industrial controls, ignition, sales engineering. Qualified in automatic temperature and propeller pitch controls and automatic pilots. Previous positions: head of research lab, central office engineer, assistant chief engineer, chief engineer. Capable of directing activities and handling men. Responsible position. Available immediately. Address inquiries to Box 271, Roslyn, L.I., New York.

Aeronautical Engineer—Age 32. Professor of Aeronautical Engineering with 5 years' administrative experience as head of department in large engineering college. Industrial experience. Experience in all phases of theoretical and applied aerodynamics, performance, stability, and preliminary design. Will consider responsible position with accredited college or university, research organization, or industrial concern. Address inquiries to Box 525, Institute of the Aeronautical Sciences.

Electrical and Aeronautical Engineer—Has done graduate work in electrical and aeronautical engineering. Four years' experience as Chief Inspection Supervisor of a leading aircraft factory. Certified Ground Engineer. Desires contact with interested aircraft manufacturers or air lines for business enterprise in the East. Address inquiries to Box 524, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.A.E., New York University. 1¼ years' aeronautical research experience. Four years' stress analysis, liaison, design, production expediting with two large aircraft manufacturers. Familiar with aircraft fabrication practice. Desires responsible production management position. Address inquiries to Box 523, Institute of the Aeronautical Sciences.

Mechanical Engineer—Native Polish; Master of Science degree in Engineering. Would like to translate Polish and Russian scientific and technical papers. Address inquiries to Box 522, Institute of the Aeronautical Sciences.

Manager—M.I.T., 1922, Engineering, Administration, Mechanical and Electrical Engineering Option. Twenty-three years' experience in industry as Industrial Engineer, Plant Engineer, Production Manager, General Manager. Last 5 years with prominent U.S. corporation as General Manager in Divisions manufacturing aircraft generators, motors, controls, and marine navigational instruments and mechanisms. A complete résumé will be sent upon request. Address inquiries to Box 521, Institute of the Aeronautical Sciences.

Engineering Test Pilot—Four thousand hours of flight engineering experience. Thoroughly qualified in aerodynamics, stabilities, vibrations, and experimental flying, together with the correction and submission of all flight-test data. Address inquiries to Box 520, Institute of the Aeronautical Sciences.

Field Representative—Quick to analyze and detect trouble. Engineer-mechanic training. Formerly technical representative for Wright and Ranger. Constellation experience gained at Lockheed Service, Burbank. Many years with Pan American Latin American Division. C.A.A. certificates. Extensive knowledge aviation fuels and oils. Free to travel. Available to progressive company. Address inquiries to Box 519, Institute of the Aeronautical Sciences.

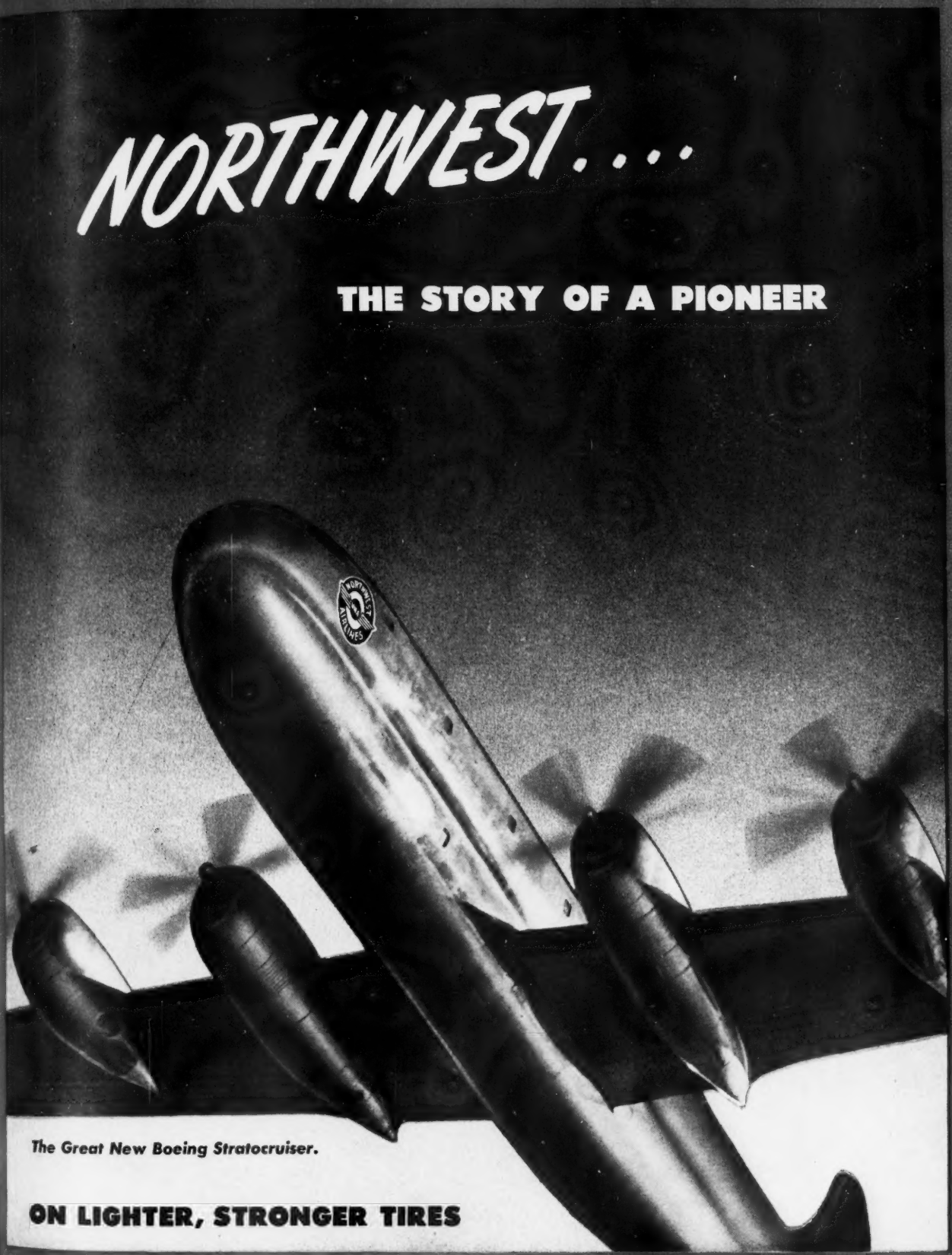
Aeronautical Engineer—Five years' experience with a leading aircraft manufacturer. Extensive experience in specification writing, weight and balance control, layout and design. Inventive ability and production minded. Experienced in supervising a large group. Desires a permanent and responsible design position in progressive organization in New York area where his experience and abilities can be fully utilized. Address inquiries to Box 517, Institute of the Aeronautical Sciences.

Aeronautical Engineer—1938. Two years as detailer on hydraulic, mechanical, and electrical equipment for aircraft. Four years as development engineer in the research department of a large aircraft company; was partially responsible for complete engineering (basic design, performance prediction, prototype construction, and flight test) of a small airplane. Now directing the activities of a group of mechanical, chemical, and industrial engineers as Supervisor of Production Engineering and Tooling for a nonaircraft company. Desires to re-enter the aeronautical field in a responsible position in development work for an aircraft company. Would be particularly interested in assuming responsibility for the complete development of a new private airplane project. Available July 1. Address inquiries to Box 515, Institute of the Aeronautical Sciences.

Aeronautical Engineer and Pilot—B.S. in Mechanical Engineering, M.S. in Aeronautical Engineering, both from M.I.T. Six months' experience as aerodynamicist with large aircraft company in design and performance analysis of large transport and military aircraft. Familiar with C.A.A. performance and operating requirements of transport aircraft. 1,700 hours flying experience in all types of aircraft includes 1,300 hours of twin- and four-engined time. Two and one-half years in Air Transport Command as pilot on air-line operations with some administrative experience as operations officer. Commer-

NORTHWEST....

THE STORY OF A PIONEER



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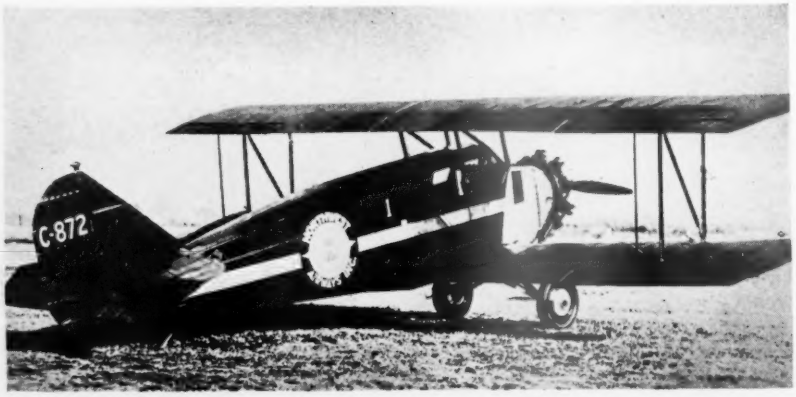
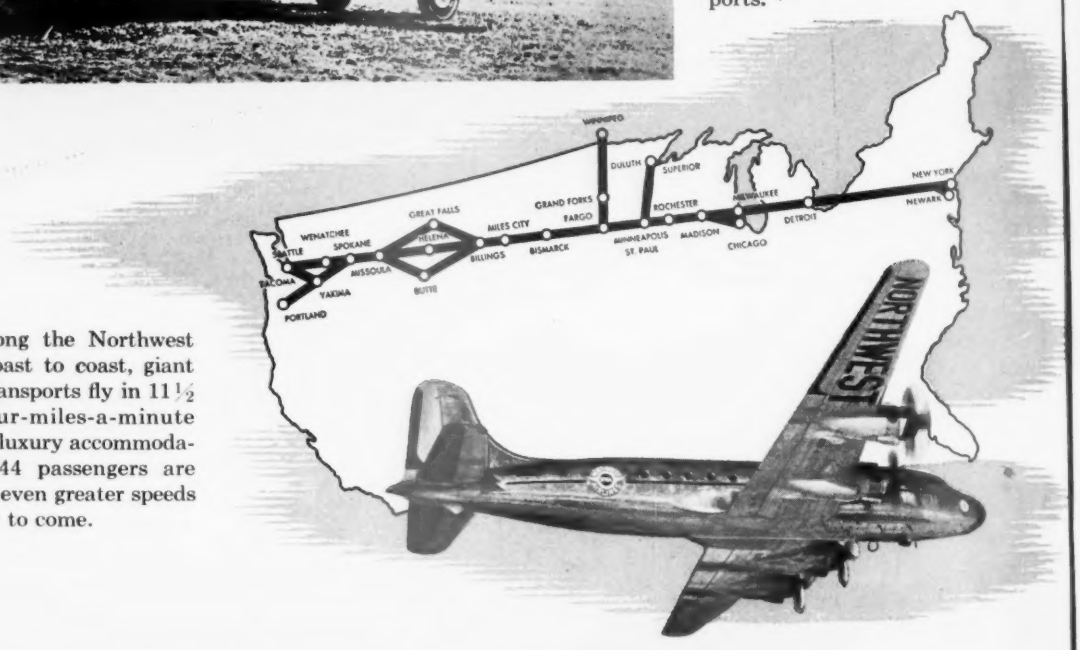
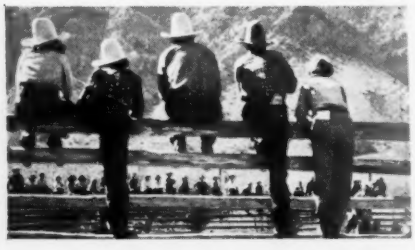


1926 One of the three Stinson-Detroiter cabin planes which flew the mail on Northwest Airway's route between Minneapolis and Chicago. Averaging 70 pounds of mail to the round trip, these planes, pioneers all, were the forerunners of today's luxurious transports.



1946 Along the Northwest Passage, coast to coast, giant 4-engine transports fly in 11½ hours. Four-miles-a-minute speed, and luxury accommodations for 44 passengers are samples of even greater speeds and luxury to come.



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UNITED STATES

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Eighty passengers will ride in lounge chair comfort high above the weather in the pressurized Boeing Stratocruiser. The upper deck is shown above; below it, a spiral stairway leads to a smart cocktail lounge that easily accommodates 14 persons.

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cial pilot, single- and multiengined land, flight instructors' ratings. Six months' administrative experience with small nonaeronautical manufacturing concern. Prefers position involving flying. Address inquiries to Box 514, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.S. in Ae.E., Purdue University; M.S. in Ae.E., New York University; studying for Sc.D. at M.I.T. Age 25, single. Desires position as aerodynamicist. Available July, 1946. Address inquiries to Box 513, Institute of the Aeronautical Sciences.

Mechanical Aeronautical Engineer—B.S.M.E. (Aero Option); 29 years old; 6 years' experience on propellers and propeller accessories and manufacture of precision parts. Two years as design engineer on helicopter rotors and controls. Some experience in textile machinery and power chucks. Desires responsible position as design or project engineer in Eastern area. Address inquiries to Box 510, Institute of the Aeronautical Sciences.

Design Engineer—Five years' college education and 6 years' experience in the aeronautical field. Has been with several well-known firms on both coasts. Desires a supervisory or group leader position to initiate and carry through design features. Address inquiries to Box 509, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.S. in Ae.E. Three years' experience as assistant project engineer with prominent light plane company. One year as research engineer. Experienced in structural design, static testing, aerodynamics, and flight-test work. Familiar with C.A.A. requirements. Married; 28 years old; private pilot. Address inquiries to Box 508, Institute of the Aeronautical Sciences.

German Translations—Accurate translations of German technical literature in aeronautics and related sciences. Address inquiries to Box 507, Institute of the Aeronautical Sciences.

Aeronautical Administrative Engineer—Englishman with 18 years' aeronautical experience; A.F., Royal Aeronautical Society; Mechanical Sciences Degree (B.A. Cambridge University). Spent from July, 1938, to December, 1945, on British Government service in U.S.A. At present with Aeronautical Inspection Directorate in England. Speaks some French and a little Polish. Desires position with commercial air line anywhere, but preferably in Europe. Address inquiries to Box 506, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.S. Ae.E. from Indiana Technical College. Three years' total experience in aircraft design, overhaul, and maintenance. One and one-half years' duty in connection with aircraft maintenance as a commissioned officer in the Naval Reserve. Desires position in connection with aircraft design, production, or service. Available July 1, 1946. Any location. Address inquiries to Box 505, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.S. Ae.E. from the University of Texas. Member of Tau Beta Pi and Pi Tau Sigma. Some postgraduate work. At present is Ensign (A) L, U.S.N.R., with duties as administration officer at a naval air station. Prefers work in design or aerodynamics. Will be available about June 15. Address inquiries to Box 504, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.S. in Ae.E., B.S. in E.M. Five years' experience in design, layout, and stress analysis of large and small military and commercial airplanes with major aircraft companies. Now holds Structural Engineer rating. Experience in supervision of stress analysts, liaison engineers, and salvage engineers. Well grounded in preliminary design. Desires responsible position in aircraft or other concerns utilizing light metal stressed construction in Mexico or other Latin-American country. Available immediately. Details upon request. Address inquiries to Box 503, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.S. from Rensselaer Polytechnic Institute. Age 23. Recently discharged from U.S. Navy after 3 years' active duty as aeronautical engineering specialist. Military experience includes 2 years as air group engineering officer in charge of maintenance, repair, and servicing of all models and types of naval carrier aircraft and engines, and 5 months in the assembly and repair department of a naval air station. Desires permanent position with West Coast aircraft concern. Prefers work in aerodynamics research or stress analysis. Address inquiries to Box 502, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Young, Chinese; 4 years' engineering experience; excellent connections. Desires a permanent and responsible engineering, sales, or technical position with aviation company or allied industry in China or in the Far Eastern territory. Address inquiries to Box 501, Institute of the Aeronautical Sciences.

Pilot—Engineer—B.S. in Ae.E., 1943. World War II veteran. Two years in Army Air Corps on heavy and very heavy bomber-type aircraft. Holds valid commercial pilot certificate. Prefers position involving engineering and flying but will consider engineering alone. Will locate anywhere. Address inquiries to Box 500, Institute of the Aeronautical Sciences.

Aeronautical Engineer-Aerodynamicist—B.S. Ae.E. Ten months' research experience testing wings, tail surfaces, propellers in wind tunnel. Six months' aircraft-engine research and development. Available immediately. New York area preferred. Address inquiries to Box 499, Institute of the Aeronautical Sciences.

Assistant Sales Manager—B.S. in M.E. Age 33; married. Ten years' aeronautical experience with two large companies. Before the war was Assistant to the Sales Vice-President of aircraft accessory firm, with extensive traveling experience. Now Major in Air Corps on terminal leave. Address inquiries to Box 497, Institute of the Aeronautical Sciences.

Aeronautical Engineer—World War II veteran; B.S. in GE with AE option from Georgia Tech. Twenty-four years old; 2 years', 8 months' experience in the development of aircraft engines (conventional and jet) and propellers in the Engineering Division, Air Technical Service Command, Wright Field. Available after June 1, 1946. Will locate anywhere. No objection to traveling. Address inquiries to Box 496, Institute of the Aeronautical Sciences.

Manufacturing Executive—Twenty years' experience in engineering and production, both United States and England. Desires connection with small concern where experience and ability can prove results. East Coast preferred. Available one month's notice. Address inquiries to Box 495, Institute of the Aeronautical Sciences.

Airline Engineer—For embryo air lines in need of financial analyses and operational and management studies. Has two aeronautical engineering degrees (working for third). Six years' aeronautical experience—air line, manufacturing, teaching. Address inquiries to Box 494, Institute of the Aeronautical Sciences.

Power-Plant Designer—Age 26, Mechanical and Aeronautical degrees. Five years' experience with powerplant installation problems including cowling and cooling, duct design, and exhaust systems. Recent experience in turbojet engine installation work, including induction systems, tail pipe, and nozzle. Excellent references. Address inquiries to Box 493, Institute of the Aeronautical Sciences.

Aeronautical Engineer—(New Zealand). First Class Honors, B.Sc. Degree at London University. Three years' postgraduate work in mathematics. Eight and one-half years' experience in major English aircraft firm, including 2 years in workshops, 1 year in wind tunnel, 3 months in stress department, and the remainder on aerodynamics and project design, such as performance, general aerodynamics, wing section theory and design, and flutter and stability control (for which now responsible). Three years on flight-test work as observer, combined with above work. Desires responsible engineering posi-

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tion. Available immediately, subject to travel facilities from Great Britain. Address inquiries to Box 491, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Age 24; married. B.S. in Aeronautical Engineering. Two and one-half years' training and experience in maintenance and repair of all Navy-type aircraft and engines. Desires connection with air line or aircraft manufacturer in an engineering capacity. Address inquiries to Box 489, Institute of the Aeronautical Sciences.

Engineer—Design or Administrative—Twenty years' practical experience in aircraft design and administration with well-established firms. Design experience includes preliminary, proposal, and manufacturing phases of both fixed and rotary wing aircraft. Desires position of responsibility in either design or administration. East Coast preferred. Address inquiries to Box 488, Institute of the Aeronautical Sciences.

Engineer—Aeronautical, Sales and Personnel—Ex A.A.F. Major, recently released by Air Technical Service Command. Age 32; married. Military experience: 3 years as Engineering Officer at one of largest bomber plants, assisting contractor in handling engineering with prime designer and A.A.F.; approximately 1 year as service liaison engineer. Civilian experience: 1 year as Director of Personnel and Labor Relations for a leading aircraft accessory manufacturer; 3 years as sales engineer, and creator and organizer of that department for same company; 3½ years' diversified experience in retail sales, aircraft and allied industry production and engineering. Desires connection wherever experience can be best utilized. Excellent references. Address inquiries to Box 487, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Graduate with 12 years' practical experience in aircraft-engine design. Familiar with engineering, development and testing of superchargers. Two years' experience as Chief Engineer in plastics plant for aircraft turrets and noses. Desires engineering position preferably supervisory. New York area preferred. Address inquiries to Box 486, Institute of the Aeronautical Sciences.

Pilot—Marine Air Corps; age 24. Commercial license with single, twin, land ratings. Partial college education in business administration. Previous practical business experience; small-scale sales experience. Desires position with aviation firm or aviation products firm in sales-contact, field representative work. Future opportunity primary consideration; salary secondary. Address inquiries to Box 485, Institute of the Aeronautical Sciences.

Aeronautical Engineer — B.S. Ae. Navigation and drafting experience in U.S. Army Air Forces. Desires position as draftsman or aerodynamicist with air line or manufacturer. Location open. Address inquiries to Box 484, Institute of the Aeronautical Sciences.

Aerodynamicist — B.Aero.E. with distinction from the University of Minnesota; age 26, married. Four full years' experience with prime Navy contractor in stability and control, compressibility, wind-tunnel test, performance, and aerodynamic design of all types of aircraft. Desires position with aircraft, business, or educational organization. Opportunities to apply knowledge and to advance are of primary interest; salary secondary. Any location considered. Available immediately. Address inquiries to Box 483, Institute of the Aeronautical Sciences.

Research Professorship—Or equivalent nonindustrial research connection is desired by aircraft engineering executive, who wants to change from industrial work to fundamental research in applied physics and theoretical aerodynamics. Sc.M. in Aeronautical Engineering from Massachusetts Institute of Technology. Twenty years' experience as head of aircraft engineering department. Address inquiries to Box 482, Institute of the Aeronautical Sciences.

Physiological Psychologist—Ph.D. 1939. Ten years' research experience in the field of human engineering in aviation, including vision, visibility, cockpit illumination, exterior lighting of aircraft, instrument lighting, hearing, speech intelligibility, anoxia, fatigue, drugs, selection, crash analysis, in-flight and preflight feeding, and passenger comfort. Formerly college instructor; at present, Officer-in-Charge, Navy Lighting Projects. Desires position with an air line to develop a program of "Test and Evaluation," preferably in Department of Engineering Research and Development. Will advise engineering staff on human engineering and will test and evaluate equipment, present and proposed, with respect to efficiency of pilot and crew and to passenger comfort. Address inquiries to Box 480, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Former Army pilot (all types) and engineering officer. Many years' experience in design, inspection, manufacture and test. Hydraulics and supercharger specialist. Broad knowledge of aerodynamics, thermodynamics, and design practice. Excellent engineering draftsman; holder of patents; many ideas for future development. Desires development work on engines or airplanes. Address inquiries to Box 478, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.Ae.E. degree. Civilian experience: 1 year as aerodynamicist specializing in wind tunnel. Military experience serving with Navy as aircraft engineering officer. Age 25, married. Available in July. Desires responsible position in East or Mid-West as Aerodynamicist or Flight Test Engineer. Address inquiries to Box 475, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.S.Ae.E. degree, 26 years old, World War II veteran. Six months' experience as Fuel System Design Engineer with Air Technical Service Command, U.S.-A.A.F. Over three years' experience in the U.S. Air Corps as Flight Engineer and Maintenance Chief on heavy bombardment-type aircraft. Experienced in supervising groups. Desires a permanent design or layout position with aircraft manufacturer. Any location in the United States will be considered. Address inquiries to Box 474, Institute of the Aeronautical Sciences.

Administrative Engineer—B.A.E. Seven years' experience in airplane design (preliminary and production), research, shop work, factory liaison, and salvage work. Group Leader. Airplane and helicopter experience. Available as assistant to busy executive in general management or engineering; aircraft or allied field. New York area preferred but not essential. Address inquiries to Box 473, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.S. in Ae.E., 14 years' flying and 12 years' engineering experience including design problems, development of test and control devices, performance studies and conduct of airplane, power plant and accessory flight-test projects, seeks product-improvement position requiring design aptitude and test ability. Interests not restricted to aircraft field provided employer can benefit from aviation background. Address inquiries to Box 471, Institute of the Aeronautical Sciences.

Aircraft Power Plant Engineer—B.S. in M.E.; 12 years' in aviation with leading aircraft and engine manufacturer. During recent years in charge projects, including personnel, involving installation, operation, maintenance, and overhaul of aircraft powerplant equipment. Qualified to assume complete management of such projects. Wide acquaintance with key personnel airlines, aircraft manufacturers, distributors, service bases, A.A.F., and Navy Bureau of Aeronautics. Travel or live anywhere. Address inquiries to Box 470, Institute of the Aeronautical Sciences.

Chief or Assistant Chief Engineer—M.I.T. graduate, age 36, extensive background in research and development work and air transport engineering. Ex-Lieutenant Colonel A.A.F. Formerly Chief Aeronautical Engineer of large foreign air transport division handling all phases of aircraft

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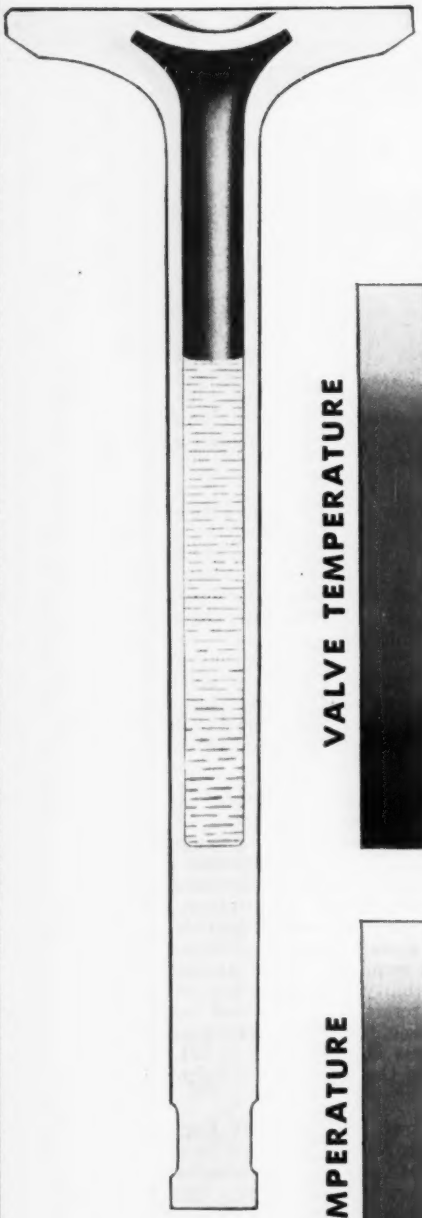

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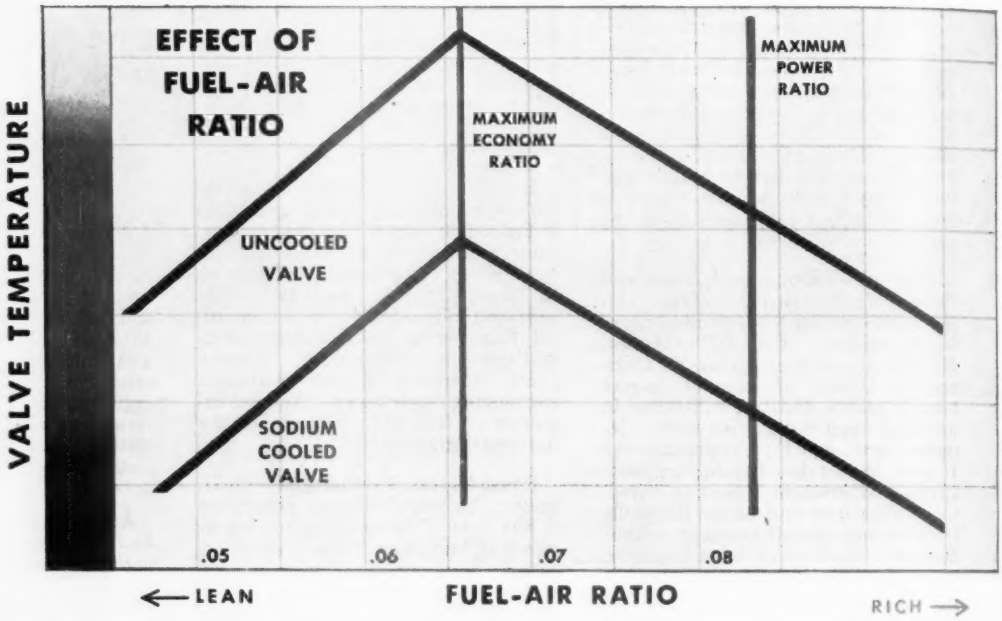

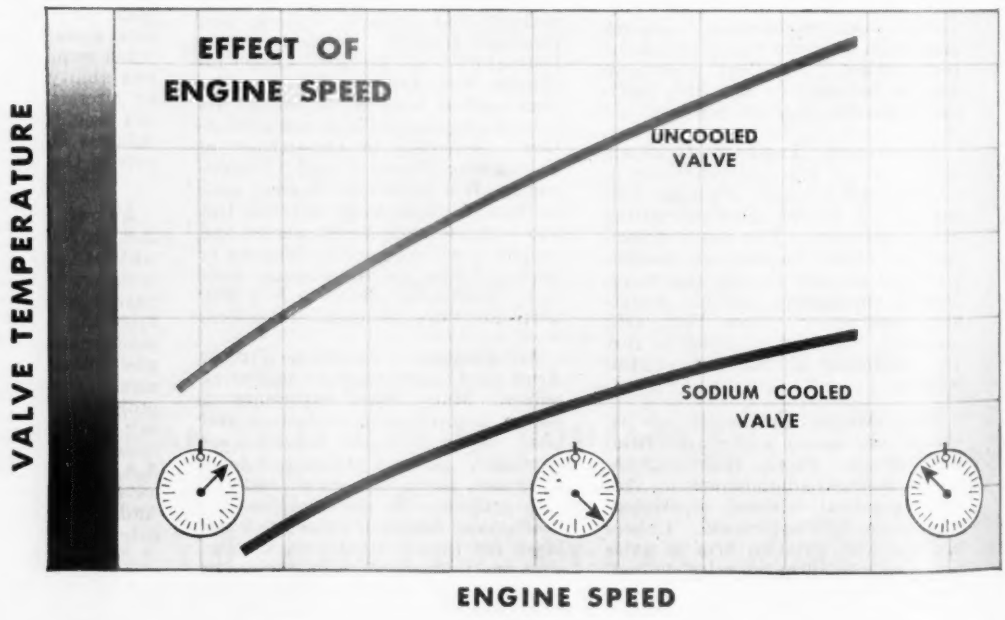

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engineering, maintenance, flight test, etc. Production engineering experience with A.A.F. Matériel Command at Wright Field. Heavy prewar experience in aircraft-engine development and testing. Desires position with good future leading to executive status. Location open; available immediately. Address inquiries to Box 469, Institute of the Aeronautical Sciences.

Expert Mechanical Design Engineer—Fifteen years' internal combustion engine design experience, including 3 years on diesel engines, 6 years on aircraft engines, last 2 years on high-temperature rotating machinery including gas-turbine aircraft auxiliary power plant. Interested in design supervision, engineering liaison, or sales engineering. Address inquiries to Box 468, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Spanish-born and educated, author of English-Spanish aviation dictionary. Will undertake technical translations into European or Latin-American Spanish; books, brochures, advertising copy. Address inquiries to Box 467, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Doctor of Aeronautical Engineering desires associate or assistant professorship in aeronautical department of university. Good teaching experience in aerodynamics and aircraft structures; several years in aviation industry on airplane design. Address inquiries to Box 465, Institute of the Aeronautical Sciences.

Tool Engineer—Aircraft and machine-shop experience; desires subcontracts for tool design, processing or special machinery. Address inquiries to Box 464, Institute of the Aeronautical Sciences.

Planning and Scheduling Engineer—M.E. degree, 1940, Carnegie Institute of Technology (Aero Option). Six years of experience. One year of experience in planning and scheduling the complete airplane before design given to project. Actual job coordinated with a representative from the factory and representative from engineering production design department and himself. Three years of experience in structural design supervision. One year of experience in engineering liaison. Desires position breaking down the design, planning the component parts and scheduling, and following its progress throughout its engineering design stages. Address inquiries to Box 455, Institute of the Aeronautical Sciences.

Management Executive—Vice-president and general manager of engineering for consulting company doing war work seeks new connection. Twenty years' experience as executive in engineering, production, and general management. Specially qualified as an organizer and production consultant. Experienced major air-line executive. Address inquiries to Box 454, Institute of the Aeronautical Sciences.

Executive—Age 37, single, Protestant, English-American. Fifteen years' continuous, well-rounded aircraft experience. Has experience in ground and flight instruction; airport and seaplane base management; airplane sales (sold over 50 aircraft prewar); charter and photographic; airline; manufacturing (inspector to factory manager); C.A.A. (inspector), quality control, engineering, research, and development. Was a key man with prime contractor (airframe) during the war (now reconverting to nonaeronautical product). Has valid commercial pilot, seven ground instructor, A. & E., radio operator, and F.A.I. glider pilot certificates. Familiar with latest metal, plastic bonded wood, and composite aircraft techniques; also conventional, amphibious, and rotating wing aircraft. Desires position where knowledge, experience, initiative, and results are of prime importance. Last salary—$7,000. Address inquiries to Box 453, Institute of the Aeronautical Sciences.

Aeronautical Engineer—With own design of practical roadable airplane having basically new and desirable features seeks connection with aircraft manufacturer who has well-established manufacturing facilities but needs a product. M.I.T. Graduate with 10 years' sound aircraft engineering experience. Address inquiries to Box 447, Institute of the Aeronautical Sciences.

Aircraft Design Engineer—Has aeronautical education. Seven years' experience in many phases of aircraft design, including layout drafting, testing, and liaison on aircraft equipment installation. Desires responsible position in engineering or experimental department of small aircraft or aircraft equipment manufacturer, or air line. Willing to travel. Address inquiries to Box 445, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Twenty-two years old. Will graduate March 29, 1946, from aeronautical school. Has lived in Spanish-American country for 16 years. Writes and speaks Spanish and English fluently, thoroughly acquainted with Latin customs. Desires position in which engineering training and knowledge of Spanish and English would be of value, either in the United States or Latin America. Address inquiries to Box 444, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.S. in A.E.; age 32. Experienced in layout, design, stress analysis, and supervision in plywood and all-metal aircraft and helicopters including basic design and simplification of structures. Desires position in Mid-West if possible. Present location, Detroit. Address inquiries to Box 441, Institute of the Aeronautical Sciences.

Mechanical Engineer—M.S.E.; 32 years old; with good background in mathematics, applied mechanics, vibrations. Varied experience in research, development, and testing of mechanical products. Thoroughly familiar with mechanical laboratory methods and equipment. Desires position requiring such knowledge and experience, preferably with research and development organization. Address inquiries to Box 440, Institute of the Aeronautical Sciences.

Engineer—Administrative Liaison—Aeronautical Administrative Engineer—Seven years' air-line operation maintenance experience with international air line and U.S. Naval Air Transport Service. Lieutenant Commander, Squadron and Staff Engineering Officer. B.S. in Mechanical Engineering (Aero Option), University of California. One year, Harvard Business School. Permanent position with international transportation concern desired. Available immediately. Address inquiries to Box 439, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Fourteen years actively engaged in the aircraft industry, including project design, flight test, and development engineering, and as representative in procurement and field service. Thorough knowledge of maintenance and flight operation, including A. and E. licenses and 7 years' flight experience. Present affiliation with major aircraft company, entered in 1937. Desires permanent responsible position and opportunity for advancement, commensurate with ability, in development, sales, or as technical representative. Geographical location unimportant. Four years of university work and graduate of two leading schools of aeronautics. Understands Spanish and French. Excellent commercial and military references. Address inquiries to Box 436, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.Ae.E., University of Minnesota. One year detail design and minor layout drafting. Over four years' service with Air Technical Service Command, U.S.-A.A.F., as engineering officer. Military experience included one year of checking contractor-submitted stress analyses and the design and supervision of installation, in aircraft, of experimental equipment; three years as resident liaison engineer for A.A.F. at large West Coast aircraft manufacturer. Served three months in England and Germany with Air Technical Intelligence Section of U.S.

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Engineering Draftsman—Four and one-half years' experience in aircraft work, 1 year, sheet metal layout; 6 months, tool design; 2 years, aircraft hydraulics; and 1 year, shop liaison. Three years of college. Desires position in Chicago area with organization offering future. Will consider position in other than aircraft industries, but aircraft industry preferred. Draft exempt. Excellent references available June 1. Address inquiries to Box 433, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Graduate work in Ae.E. Almost 6 years' experience in flight test, stability and control, and wind-tunnel testing on multiengined landplanes and seaplanes with large company. Desires stability and control or flight-test work with West Coast air line. Address inquiries to Box 432, Institute of the Aeronautical Sciences.

Engineer—Manufacturer—Eighteen years in aircraft industry. Experienced as Chief Engineer of large aircraft company during the war. Also experienced in operation of own company manufacturing subcontract aircraft parts. Desires position with small company having proprietary articles to engineer, manufacture, and sell. Have private pilots' license and fly own light airplane. Address inquiries to Box 431, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Officer R.C.A.F. Engineering education. Six years' aircraft maintenance, liaison inspection and engineering in manufacture and overhaul of military aircraft. Considerable technical administration work. Glider construction and design experience. Desires position whereby technical qualifications can be utilized and experience to a more advanced standing possible. Future opportunity is the prime requisite. Address inquiries to Box 430, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Five and one-half years' experience in Airline Engineering (Operation and Maintenance) and Aircraft Manufacturing. Two degrees in Aeronautical Engineering. Part time work desired. Address inquiries to Box 429, Institute of the Aeronautical Sciences.

Engineer—World War II veteran, engineering degree. Eight years' flying experience in U.S. Navy, 4 years service engineering, 2 years test-pilot and development work. Qualified in various types service planes including single and multiengine, both land and sea. Recent experience in jet-propelled aircraft. Desires opportunity to do research and development work including flying. No objection to traveling. Excellent references. Address inquiries to Box 427, Institute of the Aeronautical Sciences.

Air Passenger Research—College graduate, experienced. Available temporary or permanent. Address inquiries to Box 426, Institute of the Aeronautical Sciences.

Chief Engineer, Mechanical, Development and Research—Wide experience, automotive and aeronautical, ball and roller bearings and all applications, gears, landing gear; initiated current propeller; mature judgment, capacity for detail, executive experience. Ability to analyze new design, foresee possibilities, and carry from start to production drawings. Now have paying consulting business but prefer direct responsibility. Address inquiries to Box 425, Institute of the Aeronautical Sciences.

Industrial Engineer—B.S.M.E. Eleven years' experience in selecting equipment and supervising installations for aircraft manufacturing processes, including experience in production of airplane motors; also 25 years' experience in the automotive engineering and production field. In a position to do consulting work as industrial engineer. Address inquiries to Box 353, Institute of the Aeronautical Sciences.

Manufacturing Executive—Mechanical Engineer with 26 years' experience in production management covering planning, procurement, tooling, procedures, precision machine-shop practice, production control, and inspection. Aircraft manufacture or kindred field. Address inquiries to Box 292, Institute of the Aeronautical Sciences.

Changes of Address

To facilitate the prompt receipt of copies of the *Journal* and *Review*, members and subscribers are requested to give the Institute 30 days' notice of any change of address.

Notices should be sent directly to the Institute of the Aeronautical Sciences, 2 East 64th Street, New York 21, N.Y.

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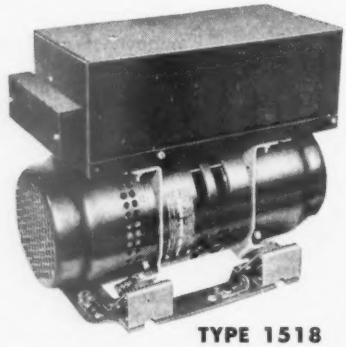

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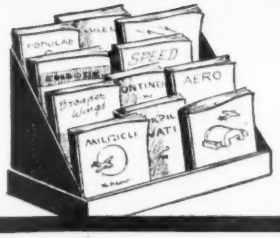

Periodicals

Accessories and Equipment

The Variable-Speed Hydraulic Governor. J. Z. Bujak. The paper deals with the development and gives the theory of a variable-speed hydraulic governor consisting of a positive-displacement pump and a pressure-operated plunger. Such an arrangement should be distinguished from a hydraulic relay as used in servo-governors. The story of its development is told, starting from the simplest possible scheme. The various troubles experienced are reported, together with the way in which they were overcome, leading to the design of a production-type hydraulic governor meant primarily for road-transport compression-ignition engines. A mathematical theory of the hydraulic governor is derived and the conditions for stable governing are established, as well as the criteria for a definite convergency of the disturbances set up by a sudden change of engine load. The magnitude of the temporary increase of engine speed following a sudden throwing-off of its load is calculated.

The results of the mathematical analysis are discussed and illustrated by numerical examples. These compare quite well with the results of experiments carried out on the engine. Some of the conclusions arrived at and the formulas derived are applicable to variable-speed governors of any type. A hydraulic governor that was developed as a result of the research described underwent several hundreds of hours of bench testing, as well as many thousands of miles of road testing. *Proceedings of the Institution of Mechanical Engineers*, Vol. 153, No. 7, 1945, pages 193–205, 17 illus.

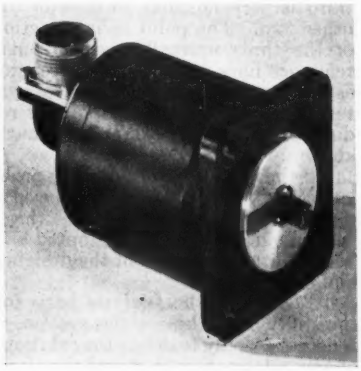

Illustration Courtesy Kollsman Instrument Division of Square D Company

The Kollsman Compak tachometer generator weighs less than 23 oz. and is stated to permit more than 50 per cent saving of space and weight over many types of standard units now installed in aircraft.

Push-Pull Mechanism Simplifies Design. John S. Baker. Design requirements for the operating mechanism of doors for pressure-cabin airplanes are stated. Because outward opening doors must be used, the latches cannot be of the fixed type. Conditions call for latches of considerable strength and a central operation handle is necessary to simplify door operation. The advantages derived from push-pull controls are noted. *Machine Design*, April, 1946, pages 114, 115, 1 illus.

Recent Developments in Aero Tyre Equipment. H. G. Conway. The use of synthetic textiles and new tread patterns has made possible tires with pressure above 150 lbs. per sq.in., although little operational experience exists at pressure over 90 lbs. per sq.in. It has been found that increased pressure limits the life of tires because of cuts made by stones and metal objects on the runway. However, the introduction of block-pattern treads on British tires is said to limit cutting to perhaps a single block. Tables and a composite graph show the following advantages of high-pressure tires: the allowable decrease in the size of tires when higher pressure is used and the consequently smaller frontal area and drag; increase in brake power; saving in weight; size of axle; size of landing gear; reduction of wheel inertia.

The writer feels that sacrifice in tire life as a result of smaller size will be justifiable on jet planes inasmuch as the cost of a pair of tires on a jet fighter is equivalent only to the cost of fuel for 60 min. of operation. The Compacta tire, recently developed by the Dunlop company, is described and illustrated. Technical features of the Compacta, including pressure, wheel size, deflection, dynamic energy absorption, rolling radius, projected area, and tire inertia are specified. *The Aeroplane*, March 22, 1946, pages 341–343, 5 illus.; "Tyres for Tomorrow," *Flight*, March 28, 1946, page 316, 3 illus.

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Package Heater Developed for Boeing Stratoliner. Harold R. Porter. The article describes in detail the packaged heater unit developed for the Boeing Stratoliner as the result of the cooperative efforts of Transcontinental & Western Air, Surface Combustion Corporation, and Minneapolis-Honeywell Regulator Company. The objectives on which the design of the heater and the method of admitting heat to the airplane have been based are enumerated. Particulars are supplied about the basic design of the heater, the heating and ventilating duct system, the operation of the system, and preliminary test results. *SAE Journal*, April, 1946, pages 191–199 (Transactions), 18 illus.

Aerodynamics

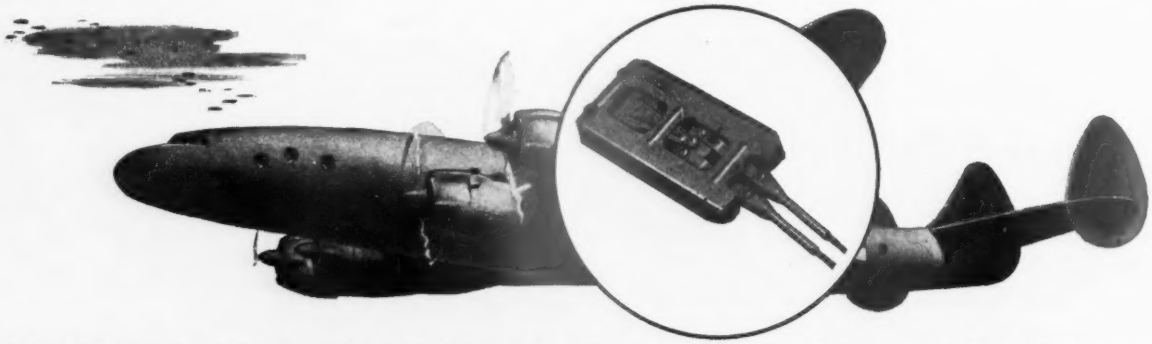
Airfoil Development and Structure Within the Cambered Surface. Part VI. Roy A. Liming. The sixth section of a serial article continues the consideration of the application of the system of analytic calculation techniques to the design of the retractable landing gear. It explains the use of the direction-number concept in the systematic and efficient development of the complete dimensional specification for the rotating movement of the mechanism and its coordination with the cambered surface and the supporting internal structure. The analysis of the kinematics of the landing gear begins with the assumption of a view along the axis of rotation, which becomes the axis of a right circular cone. To facilitate the study of the point-line-plane relationship, a special set of coordinate axes is established, defining the pivot reference system for the landing gear. The center line of pivot becomes one axis of the new coordinate system, and, with the center line of the oleo strut in the extended position, establishes the reference plane for the pivot system. Another axis is perpendicular to that plane, and a third is perpendicular to each of the other two. The point of intersection of the three mutually perpendicular reference lines forming the three axes establishes the origin of the pivot system. Calculation of this point is reduced to a simple exercise in linear algebra.

In the solution of design problems involving the thin aerodynamic profiles of high-speed wings, certain variations can be adopted and will facilitate the work of the designer and others.

To complete the analytic basis for the study of the kinematics system, it is necessary only to define the rotation-of-axes relationships between the pivot reference system and the basic fuselage "rigged" system. Instructions are given for systematizing and simplifying the problem by reliance upon the direction-number concept. The four steps in the calculation are explained, and the application of the method to specific design problems is noted. *Aero Digest*, April, 1946, pages 76–78, 117, 3 illus.

The Development of Flaps. "Elevon." Devices that enable the relationship between the lift and drag in a given wing to be modified by movable surfaces hinged to the wing are the subject of this article. It is noted that flaps fall into three main categories, namely, landing and take-off flaps, dive-brake flaps, and the more recently developed dive-recovery flaps. In order to show how the flaps may be varied to produce different results, the general rules governing their behavior are stated. The effects of these variables on the lift, drag, and pitching moment are described. *Aeronautics*, April, 1946, pages 26–28, 5 illus.

On the Propagation of Small Disturbances in a Moving Compressible Fluid. G. F. Carrier and F. D. Carlson. It is noted that little information is available about the propagation of sound waves in rotational streams, or concerning the propagation of transient rotational phenomena. The writers show that the wave fronts associated with those parts of a disturbance that are derivable from a potential propagate in a rotational stream according to the same laws that they are known to obey in an irrotational stream. It is also shown that the rotational disturbances drift with the stream rather than propagate relative to the moving fluid. The analysis consists of an application of conventional perturbation procedures to the Navier-



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Stokes and continuity equations. The equations so derived are treated according to the theory of characteristics.

The results obtained lead to a general expression for the Mach lines of an arbitrary supersonic flow and also suggest a new method of wind-tunnel calibration which eliminates the necessity of placing an obstacle in that portion of the stream being calibrated. Finally, predictions are carried out as to the nature of pulses that are formed at a surface and then propagate through a boundary layer into a uniform stream. *Quarterly of Applied Mathematics*, April, 1946, pages 1–12, 5 illus.

Air Cargo

Foreign Trade and Speed. Gen. Harold R. Harris. The former Chief of Staff of the Air Transport Command of the A.A.F. and now Vice-President and General Manager of American Overseas Airlines weighs some of the major factors involved in foreign air trade. He points out that speed is the one great asset of commercial aircraft. Headquarters of a business with foreign offices can, through the instrumentality of commercial aviation, operate its branches throughout the world with greatly increased efficiency. Another advantage is the economy that comes from reduction of inventory that formerly had to be stored at points distant from the factory or supplier, because goods can now be delivered so rapidly. The three important factors in commercial aviation—designated as fear, fare, and frequency—are considered, and statistics are supplied. An insert is included giving a brief résumé of General Harris' commercial and military aviation experience. *Air Transportation*, March, 1946, pages 7–9, 3 illus.

Air Cargo Tariffs. John H. Frederick. An examination is made of the air-traffic situation and it is concluded that the future prospects for volume movement of air cargo via certified air lines will depend on the extent to which the air lines cooperate on schedules. It is stated that the present situation, if continued, will either supply the necessary stimulation for the establishment of a unified national air-cargo service among nonair-line interests, or it will encourage the growth of nonscheduled operators throughout the nation. *Distribution Age*, March, 1946, pages 46, 80, 81.

"Rank Cargo Carriers on Their Own." John H. Frederick. It is stated that, as air transportation develops, more and more air-cargo carriers will go into operation as a business separate from the conventional air lines, operating in the contract, private, or other nonscheduled fields. Advantages which it is indicated these carriers would offer are enumerated. Consideration is given to what determines whether an air carrier is, or is not, a common carrier. Sharp revisions in C.A.B. regulations are suggested. *Aviation*, April, 1946, pages 41–43, 2 illus.

The views and opinions expressed in this section are exclusively those of the writers or publications named. They are in no case to be construed as those of the Aeronautical Engineering Review or the Institute of the Aeronautical Sciences.

Freight by Air. A survey of the business aspects of air transportation of freight begins with definitions of the terms air cargo, air express, and air freight. After a brief comparison of prewar rates with those prevailing at present, the growth of the volume of air cargo is reported, as well as the active competition provided by the large number of organizations that have recently entered the business. Appraisals of the potential air-cargo volume by various authorities on the subject are quoted, the figures varying according to the individual estimate of the rates that can be charged, from approximately 145,000,000 ton-miles at $0.17 to $0.19 per ton-mile to more than six billion ton-miles at a rate of $0.06.

The principal directions of traffic flow are estimated, as well as the classes of commodities expected to be shipped by air. Factors entering into the cost of air transportation of freight are analyzed in connection with a study of rates, and the merits of all-cargo operations are compared with conditions prevailing when combined passenger and cargo loads are carried. Types of aircraft suitable for cargo work are reviewed. The text is clarified by numerous charts showing the expansion of air-cargo traffic, the relationship of loads to costs and volume to rates, potential traffic, and other factors. A table lists the direct and indirect costs of operating an all-cargo air line. *Fortune*, May, 1946, pages 134–139, 164, 165, 167, 168, 170, 23 illus.

The irregularity of receipt of publications from abroad necessitates the review of articles in issues several months late. This is done to provide readers with information regarding foreign technical progress as soon as the issues are available in the United States.

Air Law

Bermuda Barter. F. R. Stout. An account of the first postwar Anglo-American civil aviation conference reports the decisions reached by the United States and Britain at Bermuda. The principal provisions are: (1) Fares are to be set by the air lines subject to governmental review. (2) "Fifth-Freedom" rights (the right of an air line of one country to pick up passengers in a second country for destinations in a third country) are granted under general rules designed to prevent air lines of either country from operating local rather than international flight schedules. (3) Air lines of both countries may operate as many flight schedules as they choose, without limit on plane capacities. (4) Both countries agreed upon routes covering the world. (5) "Change of gage" (substitution of a smaller airplane for a larger one, to meet traffic needs) is permitted. (6) The Civil Aeronautics Board approved the International Air Transport Association's rate-fixing machinery for 1 year, and will ask Congress for legislation cloaking it with the same authority over international fares that it exercises over domestic rates.

Political aspects are discussed and opinions are expressed concerning the policies advanced by both countries. In addition to the general transport agreement, the conference produced an agreement opening to commercial operations the military airports built by the United States on British territory under 99-year leases obtained in trade for 50 destroyers in 1940. A map shows the world routes agreed upon. *Flying*, May, 1946, pages 22, 23, 109–111, 2 illus.

Air Policy

Action on That Air Policy Is the No. 1 Must. Eugene E. Wilson. The Vice-Chairman of United Aircraft Corporation and Chairman of the Aircraft Industries Association states that consideration of military unification has sidetracked much-needed progress toward the establishment of the aeronautical program of the United States, both military and commercial. Reports of Army and Navy department heads, and testimony before Congressional Committees, and recommendations of associations are summarized, with the statement that conflicting opinions should be adjusted to give a clear policy. The writer explains why it is important to take immediate steps to reaffirm an American air policy. Such a program is suggested. *Aviation*, April, 1946, pages 38–40.

Air Power

Strategic Air Power. Gen. Carl Spaatz. The Commanding General of the Army Air Forces discusses strategic air power, beginning with a picture of the nation's precarious

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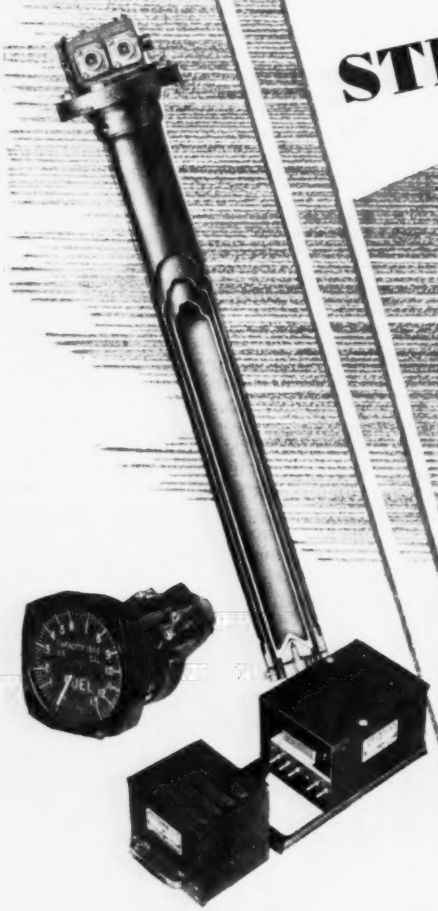

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position in 1942. The answer to that dilemma was found in a new instrument, designated as Strategic Air Power. The General states that the German strategic failure in 1940 was attributed to three causes: (1) inadequate armament on the bombers; (2) no capability for precision bombing; (3) use of fighters in close support of the bombers instead of in general support.

The strategic concept was to wage an independent air campaign, intended to be decisive, and directed against the essential war-making capacity of the enemy. The weapon was strategic bombing "around the clock," the first war instrument in history capable of stopping the producing mechanism of a great industrialized enemy. The advantage over two-dimensional techniques is that its units are not committed to position in battle; they carry out their assigned missions, and then return to base to prepare for fresh assaults. In fulfilling the concept, time was involved in "forging" the weapon. Thirteen hundred Regular Army flying officers were on duty in 1940. This nucleus expanded to a total of 2,300,000 officers and enlisted men in 1944. Time was required to prepare bases and to gain control of the air. Figures regarding total personnel, total number of aircraft, combat groups, and total number of monthly sorties and tons of bombs dropped are incorporated in a chart recording the monthly development of the effective fighting strength of the A.A.F. from 1939 through 1945.

After nearly a year of study and 6 months of investigations in Germany, the U.S. Strategic Bombing Survey issued the following overall appraisal: "Allied air power was decisive in the war in Western Europe." Enemy statements are cited in support of this view.

General Spaatz enumerates the lessons to be learned from strategic air power: (1) The time we were given to make our preparations was an absolutely essential factor in our final success. (2) Air power in this war developed a strategy and tactic of its own, peculiar to the third dimension. (3) The first and absolute requirement of strategic air power in the war was control of the air in order to carry out sustained operations without prohibitive losses. (4) We profited by the mistakes of our enemies; they discovered too late the weakness of their lack of heavy bombers; the V-1 and V-2 "flying bombs" arrived too late to affect the course of the war. (5) Strategic air power could not have won this war alone, without the surface forces.

General Spaatz believes that another war would probably be decided by some form of air power before the surface forces were able to make contact with the enemy in major battles. "That is the supreme military lesson of our period in history." *Foreign Affairs*, April, 1946, pages 385–396, 1 illus.

Peace Through Air Power. Air Vice Marshal R. P. Willock. The writer reviews the accomplishments of the Allied air forces in the recent war, evaluates the potentialities of air power, and discusses its importance in the maintenance of peace. He emphasizes that aviation cannot be ignored when either national or international security problems arise, or when international policies are being determined, because aviation alone can do so much to provide the means of promoting peace, security, and prosperity in the world. *American Helicopter*, April, 1946, pages 8, 9, 43.

Air Power and the Coming Peace Treaties. John C. Cooper. Specific clauses in the Treaty of Versailles governing air power in Germany are enumerated. The Allied objectives were the permanent military air disarmament of Germany and possible limitation of German civil aviation within German territory. With a few exceptions, Germany was left in sovereign control of her own airspace, with adequate power to reorganize her civil aviation and without any control as to the training of pilots and other personnel. Indicating the futility of the Versailles approach to the control of air power, the writer recommends international control of airports in enemy territory and prohibition of the manufacture of aircraft, engines, and parts, the training of personnel, and the storage of raw material and fuel. No aircraft could use the airspace of present enemy states until licensed by the United Nations agency, which should be trusted and given adequate power and authority to that end, in the air as well as at sea and on the ground. *Foreign Affairs*, April, 1946, pages 441–452.

Air Transport

Design for the Short Haul. Agnew E. Larsen. The article deals with problems involved in the establishment of nine short-haul air routes through territory lying between the Great Lakes and the Rocky Mountains, proposed by the Burlington Transportation Company. The nine routes comprise some 2,709 net route-miles, the average length of trip between points served being 37.65 miles. The average elapsed time for this service with the use of helicopters is compared with that for buses. The choice of equipment is discussed, and factors influencing the basic design, operation, maintenance, and expansion of services are considered. The prospects for the size and character of future equipment also are briefly surveyed. *American Helicopter*, April, 1946, pages 39, 40, 46.

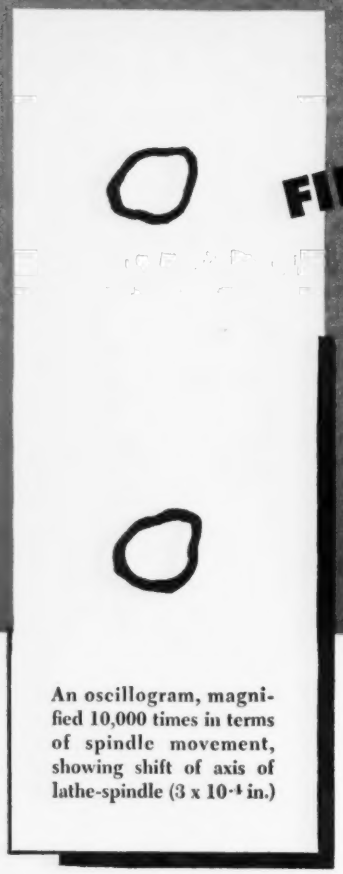
Luxury Aloft. W. E. Beall. The Vice-President of Engineering-Sales of Boeing Aircraft Company describes features that are being incorporated in the modern air liner to provide greater comfort and safety for passengers, particularly those incorporated in the design of the Boeing Stratocruiser. The writer describes provisions that have been made for adequate air and altitude conditioning, noise reduction, good vision, comfortable seating, and other comfort features. *Air Trails*, May, 1946, pages 30, 31, 7 illus.

Wanted: Local Air Service. Wilbur La Roe, Jr. The writer states that now that air trails have been blazed across the continent and over the oceans, the future development of aviation in the United States must be in the field of local and terminal service. It is indicated that experience in the railroad and motor-truck fields shows the absolute necessity of having efficient terminal operations to supplement long-distance transport facilities. The opinion is expressed that the greatest development in aviation in the next few years will consist of expanding the service to local communities and improving the terminal handling of air passengers. *American Helicopter*, April, 1946, pages 23, 24.

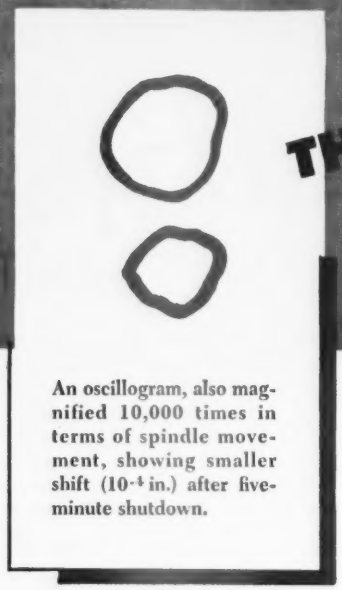
Air Travel Makes Longer Week Ends. Esther Forbes. Colonial Airlines' past record of operations is compared with the present record. The company's program and organization are outlined and sales-promotion ideas are advanced. The writer reports the methods by which seasonal fluctuations were overcome and winter passenger traffic was raised from 200 to 2,000 monthly by organizing winter-sport excursions. Similar business-stimulating methods brought large gains in summer travel to resort areas. A graph shows the growth of revenue-passenger traffic from less than 200 in January, 1937, to more than 11,000 in August, 1945. *Air Transport*, April, 1946, pages 26–31, 6 illus.; "Recreation by Air," by Esther H. Forbes, *U.S. Air Services*, April, 1946, pages 26, 28.

Air Crossroads of the Americas: The Dominican Republic. Algernon Banks. The writer reviews the history and development of air transport in the Dominican Republic, a country whose strategic location in the mid-Caribbean makes it an air-line connecting link between North and South America. It is stated that the Republic hopes to incorporate helicopters as integral units in the Dominican military and civil aviation program as soon as commercial production in the United States makes these aircraft available. *American Helicopter*, April, 1946, pages 10–12, 7 illus.

The Future of World Airlines: U.S.A. Lucien Zacharoff. Part II of a three-part study of the air-transport business in the United States



An oscillogram, magnified 10,000 times in terms of spindle movement, showing shift of axis of lathe-spindle (3×10^{-4} in.)



An oscillogram, also magnified 10,000 times in terms of spindle movement, showing smaller shift (10^{-4} in.) after five-minute shutdown.

These Photographic Recordings, by showing effects of shutdown on lathe-spindle accuracy, helped produce precision parts in quantity.

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presents an appraisal of America's air-transport status at the opening of the present period of reconversion, in which the size and other details of air-line fleets are seen fluctuating because of the changing availability of aircraft materials and man power. Particulars are supplied about the length of air routes and future air-line expansion. How improved flying equipment and other inventions are enhancing present air-line operations is briefly described. *Air Trails*, May, 1946, pages 42, 43, 70, 72, 74, 76, 1 illus.

China Will Fly. Polan Banks and Frank Tao. The future of China in the air is estimated. It is stated that the new China, which is facing a future of great industrialization and modernization, is destined to be as much a part of the air age as any of the great powers. How 8 years of war with Japan have made the Chinese air conscious as they never were before is described. Particulars are supplied about the growth of military and commercial aviation in China. *American Helicopter*, April, 1946, pages 25–27, 5 illus.

Federal or State Regulation of Aviation? John H. Frederick. The question of whether aviation should be regulated by the Federal Government or the states is considered. The ways in which air and land transportation differ are pointed out. It is explained that air transportation, by its very nature, can know no roadbed nor recognize any state line. The opinion is expressed that divided control can have a seriously retarding effect on the future growth of aviation.

A plea is made for uniformity in laws and in their interpretation and enforcement. *Distribution Age*, April, 1946, pages 50, 58, 83.

Air Power for Peace or Destruction? Andre Michalopoulos. The Minister Plenipotentiary in Charge of Information for Greece in America reviews commercial aviation in Greece before the war and outlines its importance as a vital center of future air travel. Greece's participation in the war is traced and the resultant devastation is described briefly. *Air Transportation*, March, 1946, pages 18, 20, 2 illus.

Airplane Descriptions

Hervey Travelplane Is New Roadable Project. A brief description is given of the Travelplane Model 25, a four-place roadable personal aircraft that is being developed by George H. Hervey, of Roscoe, Calif. The chief innovation is the proposed use of a single dural tail boom passing through the tubular pusher-propeller shaft and supporting the tail surfaces. The power plant is to be a 200-hp. Ranger, alternatively driving the propeller and the two main wheels of the tricycle landing gear. A cruising range of 4 hours at 125 m.p.h. is planned. The wing span is 36 ft. *Aviation*, April, 1946, page 100, 1 illus.

The Bristol 170. Parts I and II. The first in a series of articles giving additional details about the Bristol 170 examines production, maintenance, and estimated running costs of the two versions, the Freighter and the Wayfarer. The Bristol 170 is a high-wing metal monoplane powered by two Bristol Hercules 131 engines of 1,675 hp. each, driving four-bladed Rotol or de Havilland constant-speed propellers. Gross weight is 36,500 lbs. The Wayfarer has accommodations for a maximum of 40 passengers and the Freighter is designed for up to $4^1/_2$ tons of freight. Steel is being used instead of more expensive alloys in production, and numerous other simplified construction methods have been devised to reduce the costs of building and operating the airplane. The B.O.A.C. check system is recommended by the builder for maintenance. This entails five checks, consisting of (1) daily check; (2) a minor at 50 hours; (3) an intermediate at 200 hours; (4) a minor-major at 400 hours; and (5) a major at 1,200 hours. A thorough cost analysis includes the initial cost of the aircraft, now expected to be below the predicted rate of £1 per pound of gross weight, as well as the entire estimated operating costs based, first, on a 300 air-mile flight with 60 per cent reserve of fuel, and another list based on a 500 air-mile flight. The total costs per hour are respectively £23 10*s.* 11*d.*, and £22 10*s.* 11*d.*

Part II summarizes the considerations that led to the construction and performance of the Bristol 170. Economy of operation and maintenance dictated the use of a fixed, faired landing gear, limited range and cruising speed, and other features, with a view toward meeting the competition of surface transportation for distances of 500 to 600 miles. However, with greater latitude in the matter of costs, the performance can be greatly improved. The construction of the fuselage, its interior equipment, wings, and control surfaces are described in detail. Additional specifications are included in text and tables. A construction drawing of the interior of the aircraft occupies two pages. *The Aeroplane*, March 8, 1946, pages 288–291, 7 illus.; March 15, 1946, pages 314–319, 7 illus.; "Bristol '170' Transport Plane," *Aero Digest*, April, 1946, pages 54, 55, 165, 166, 2 illus.

The New Fox Moth. It is announced by the de Havilland Aircraft of Canada, Ltd., that the Fox Moth is again being produced. Although the basic design is essentially unchanged, the postwar model incorporates refinements and improvements, including an increase in power. Equipped with a Gypsy Major 1C air-cooled, four-cylinder, in-line inverted engine of 149 hp., the average fuel consumption is reported to be 6.4 Imperial gal. per hour. Designed for operation as a landplane, seaplane, or skiplane, the craft has a landing gear of the divided-axle type. The changes in specifications and the equipment of the new model are summarized. *Aircraft and Airport*, February, 1946, pages 27, 28, 2 illus.

Ross Sport Plane Set for Production. Particulars are given about the Ross-2L Sport Plane, a tandem two-seater for flying-school operators and personal pilots, which is scheduled for large-scale production at an early date. It is a product of the Ross Aircraft Corporation, of New York City. A feature of this plane is simplified structure to provide ease of production and low maintenance cost. It has a wing span of 30 ft., length of 20 ft., height of 7 ft., and is powered by a 65-hp. Lycoming engine. The top speed is stated to be 103 m.p.h., cruising speed 90 m.p.h., and landing speed 38 m.p.h. The weight empty is 555 lbs. and the gross weight is 995 lbs. *Aviation*, April, 1946, page 95,1 illus.

Two-Control Sky Skooter Is Thorp Entry. Specifications are given for the Sky Scooter, a two-place, side-by-side, all-metal personal plane that is being built by the John W. Thorp Company, Burbank, Calif., and is scheduled for flight tests during the summer of 1946. It is stated that the plane is planned for a cruising speed of 100 m.p.h., landing speed of 35–40 m.p.h., and a 400-mile range. Service ceiling will be about 16,000 ft. and initial climb about 650 ft. per min. Take-off over a 50-ft. obstacle in 500 ft. and landing over a similar obstacle within 400 ft. also will be sought. These performances are calculated on installation of a lightweight two-cycle 50–60-hp. engine. The span is to be 25 ft. and length 17 ft. 6 in., but, notwithstanding this small size, a cabin width of 39 in. at shoulder level is planned. "Spinproof" and "stallproof" controls are to be installed. *Aviation*, April, 1946, page 93, 1 illus.

Légers Avions. The features of French personal aircraft are described in a summary of details given out by the Ministère de L'Armement. These aircraft include the S.E. 2100, the Fellot-Lacour, Max Holste M.H. 52, S.U.C. 10, Nord 1101, S.E. 2300, Morane Saulnier 560 and 570, M.S. 560, M.S. 570, and Guerchais Roche T. 35. *Aeronautics*, April, 1946, pages 32–35, 8 illus.

British Civil Transports. Specifications of recent British air-transport aircraft are assembled in uniform style, together with illustrations. Specifications are tabulated under headings of type, engines, span, wing area, loaded weight, cruising speed

and miscellaneous notes. The following are the aircraft listed: Airspeed A.S. 65 Consul, Avro 652 A Type XIX, 691 Lancastrian, 685 York, Tudor 1, and 689 Tudor II; Bristol 170 Freighter; de Havilland D.H. 104 Dove; Handley Page H.P. 70 Halifax C. Mk. VIII and H.P. 68 Hermes; Miles M.57 Aerovan; Short S.25/V Sandringham and S.45 Solent; and Vickers V.C.1 Viking.

In addition to the aircraft illustrated, brief facts are given concerning other recent British transports, including the Airspeed A.S. 57 Ambassador; Bristol Type 167 Brabazon; Cunliffe-Owen Concordia; Miles M.60 Marathon; and the Short Shetland. *The Aeroplane Spotter*, April 6, 1946, pages 78, 79, 14 illus.

Airspeed Consul. The R.A.F.'s standard twin-engined trainer, the Airspeed Oxford, has been modified for civil use and renamed the Consul. This feeder-line plane carries 1,020 lbs. of pay load, with a range of 590 miles at 155 m.p.h. at 10,000 ft. During the conversion from Oxford to Consul, minor modifications were made to improve handling qualities. The aircraft is powered by two Armstrong Siddeley Cheetah X engines, and Fairey Reed fixed-pitch metal propellers have been standardized. *Flight*, April 11, 1946, page 357, 2 illus.

A Russian Single-Seat Fighter. The Russian YAK-3, a fast-climbing, low-altitude interceptor, is described from information supplied by a French fighter pilot who flew the airplane on the Russian front. The engine is a 12-cylinder, upright V-type, liquid-cooled, Hispano-Suiza unit of French design and built in Russia, having a maximum power rating of 1,310 b.hp. An American Hamilton Standard propeller with variable-pitch and constant-pitch controls is used. Instrument flying must be accomplished by the use of primary instruments alone because of the absence of gyroscopic instruments, and because of inferior compasses, radio operating on one channel only, and no homing device or distress signal. Armament consists of one 20-mm. cannon, firing through the propeller hub, and two 0.303-in. machine guns. *The Aeroplane*, March 22, 1946, pages 346–348, 4 illus.

The S.N.C.A.S.O. SO-30R Bellatrix. The recent SO-30R Bellatrix, produced by the Société Nationale de Constructions Aéronautique du Sud-Ouest, is briefly described and illustrated. Total fuel capacity is 838 gal. Of monocoque construction, the fuselage accommodates 30 day passengers or 16 sleeping passengers in three cabins. The fuselage is sealed with rubber, and internal pressure is provided to simulate the equivalent of a reduction of 11,500 ft. in altitude. Two three-blade, reversible-pitch propellers and retractable tricycle landing gear are used. Dimensions, weights, and performance data are supplied. *The Aeroplane Spotter*, April 6, 1946, page 77, 3 illus.

Airports and Airfields

Runway Patterns. Principles of runway layout are summarized. It is explained that four main principles may be distinguished in the runway patterns which are in use at, or have been adopted for, primary airports. They are the tangential pattern; the triangular pattern; the unistrip pattern; and the multistrip pattern. A variant of the tangential pattern is the two-strip pattern. It is noted that applications of these four principles are found at four important airports, located in London, Paris, Warsaw, and New York. Each principle of construction is studied and illustrated by diagrams. *Aeronautics*, April, 1946, pages 43–47, 11 illus.

Terminal Building Design for Intermediate Airports. Lee J. Bregenzer. Economic and functional problems involved in the design of terminal buildings for Class III or Class IV airports are considered. The importance of designing buildings with thought to future expansion is emphasized. It is stated that a simple, straight-line building design will prove both flexible and economical because the size can be increased by building on the ends. The writer presents plans and information about a basic design of a Class IV airport terminal building incorporating economy, efficient function, and flexibility. *Aviation Maintenance & Operations*, April, 1946, pages 24–27, 5 illus.

What Price Service. Joe James. Civilian traffic, making up only 5 per cent of the small airport's total volume of business, is found to be unprofitable at present and a cause of the operator losing money on transient servicing. The writer explains the airport operator's difficulty in offering efficient line service to transient aircraft but emphasizes the advantages of establishing a good reputation for service, in view of the expected increase in traffic. *Southern Flight*, April, 1946, pages 52, 53, 3 illus.

Airport Building In Indiana. Frank Maher. Plans for Indiana's proposed airport-construction project are outlined, with a report of the number and condition of existing airports throughout the state. In 5 years the existing 135 airports are expected to be increased to 225; in 10 years, to 300. Indiana is credited with having built 100 airports in the 18-month period beginning October, 1944. It is stated that the city of Indianapolis will need 19 airports within its metropolitan area to provide for the air traffic estimated for the near future. *Airports*, April, 1946, pages 50–52, 6 illus.

Foam Quells Aircraft Fires. National Foam System's fire-fighting foam, used throughout the war by the Navy and merchant marine, is described. The material is reported to be available now for civilian airports and aircraft. The uses and functions of this foam are defined in detail. *Aero Digest*, April, 1946, pages 62, 104, 2 illus.

Airport Design: (3) Metropolitan Land Airports. Part II. J. P. Chaplin. In the second part of the third article in a series on airport design, the ground-floor plan of a metropolitan land airport building is diagrammed and labeled. The text explains the function of each section of the building and its relation to the other sections and to the general plan. The building is designed to facilitate the normal traffic flow. *Airports & Air Transportation Supplement of Parks and Sport Grounds*, March, 1946, pages 12, 13, 1 illus.

Skytel Number Two. The second in a series of articles about hotel accommodations at airports describes a medium-priced stopover point for the personal pilot. Skytel provides a landing strip, servicing facilities, and quarters for the night. It is also designed to accommodate automobile-tourist trade. The four essential elements are specified as a combined restaurant and lounge, a manager's office, maintenance and minor-repairs hangar, and overnight sleeping quarters with a minimum of nine rooms. The problems of location, living quarters, hangars, building materials, insurance, and financial arrangements are analyzed. First costs are intended to be met by the revenue from automobile traffic. *Skyways*, May, 1946, pages 36–38, 4 illus.

Municipal Obligations in Airport Operations. John H. Frederick. The writer discusses municipal ownership and management of airports and the means by which municipal ownership can be made economically sound. The method of leasing space at city-controlled airports to private operators is analyzed. A list of probable renters of space is included, and management problems are outlined, with advice concerning the more profitable type of leases. A form of contract suggested as a model lease for the airport operator is reproduced. *Southern Flight*, April, 1946, pages 49, 50.

Nebraska's Airport Boom. Lawrence Youngman. Nebraska's airport program is described in detail. Few towns in the 3,000- to 10,000-population group are without either an airport or plans for building one. The communities are raising the money with the aid of the State Aeronautics Commission and the Nebraska State Department of Aeronautics. These departments are able to assist local communities because of the five-cent tax on aircraft gasoline. Crops are planted along runways for further financial assistance. Other means for financing the building of airports are related. The opinion is expressed

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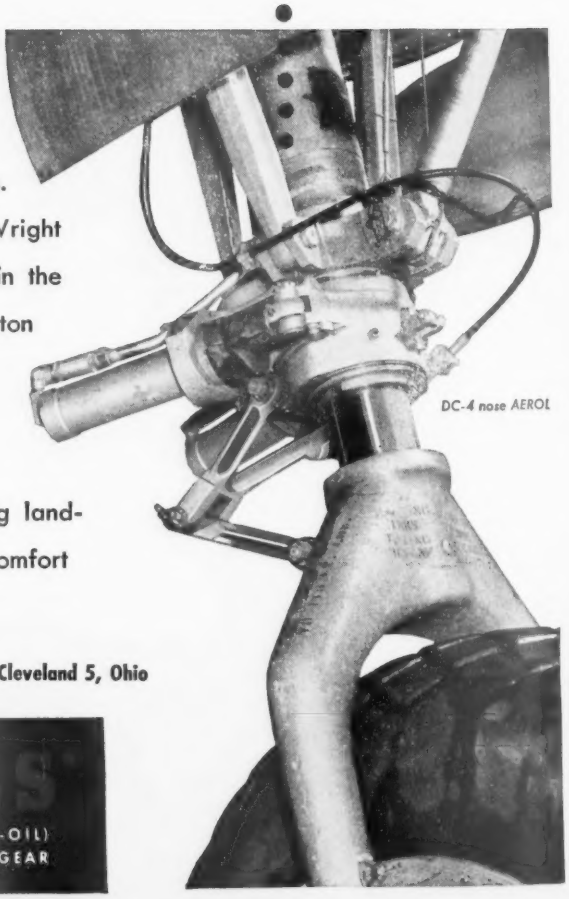

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that light planes will be of great benefit to farmers. *Flying*, May, 1946, pages 56, 57, 100, 102, 4 illus.

Increasing Airport Usefulness. J. Kirk Baldwin. The writer analyzes the necessity of making airports useful contributing factors to the business life of the community, instead of merely pleasure-flying fields. It is proposed as a solution that all first-class mail be delivered by air and that actual flight training be introduced in every high school in the United States. Both plans are studied for practicability. *Airports*, April, 1946, pages 47, 48, 2 illus.

Electromagnetic Vibration Table. R. K. Bernhard and J. G. Barry. The development referred to was undertaken for the purpose of providing equipment necessary for conducting a study of the effects of vibrations on airport-pavement performance, carried out by Princeton University for the Technical Development Service of the C.A.A. A vibration table to excite vertical and horizontal motions or a combination of both is described. It is explained that the electromagnetic drive and the table platform, acting as a two-mass system, have been used for dynamic investigations and for the calibration of instruments. The electrical control facilitates an almost instantaneous change of displacement amplitude and frequency. Mechanical and optical controls allow a continuous double check of amplitudes within a range of 10^{-5} to 10^{-1} in., for the applied frequency spectrum from 7 to 200 cycles per sec., and of the wave shape. The interchangeable parts permit adaptation to various types of dynamic research. *A.S.T.M. Bulletin*, March, 1946, pages 35–40, 11 illus.

Airport Safety. John F. Stearns. In view of the coming increase in private flying, the writer stresses the importance of airport safety. Working on the assumption that the greatest and most immediate progress in accident reduction can be achieved through the medium of better ground facilities, ground-safety factors are listed. Under the heading of operations, safety precautions are segregated into the following classifications: the field; facilities; personnel; and traffic. Under the heading of information and education, suggestions are offered with regard to flight instruction, general information, and special information. *National Aeronautics*, April, 1946, pages 14–17, 1 illus.

Survey of AAF Airport Design. Prentiss French. The purpose of this report of the survey made under the joint auspices of the Air Installation Division, Headquarters, A.A.F., and the Office of the Chief of Engineers, is to set forth some of the findings of the preliminary phase of the survey. Intended to be of interest to designers of both military airfields and civil airports, the article examines the design aspects of existing airfields and gives opinions about their adequacy.

It is concluded that unduly long runways will not be required because the increase of aircraft power will permit shorter take-off runs, and the fewer runways at one field will be used by heavier aircraft because of their ability to take off and land with cross winds. Examples of runway use by heavy bombers at three fields are cited. Runway direction was found to be influenced by convenience rather than wind direction. It is pointed out that aprons and taxiway pavements should be 25 per cent (or more) stronger than the runways because of the greater stresses imposed by standing or slowly moving loads. Centralization in layout of aprons and attendant facilities, noted at several fields, is recommended for conservation of space and surface transportation. Proper drainage facilities are advocated for safety precautions, and practicability and safety are noted in the degree of the gradients of air strips. *Aero Digest*, April, 1946, pages 46, 47, 152, 155, 2 illus.

Armament

Atomic Bombs, Special Weapons, and Future Warfare. Part II. Comdr. Grayson Merrill. The second part of a serial article in which the potentialities of recently developed weapons of warfare are evaluated and consideration given to their significance in future warfare. Using the material of the "Smyth Report," Commander Merrill endeavors to deduce the physical characteristics of the atomic bomb. He then examines the effects of these characteristics insofar as they affect the future uses of the weapon. *Air Trails*, May, 1946, pages 39, 95–98.

Atomic Energy

Operation Crossroads. Alice Rogers Hager. The preparations taking place at Roswell, Clovis, San Antonio, Albuquerque, and Oklahoma City, by the 58th Wing of the 20th Air Force, for the atomic bomb test at Bikini atoll in May are briefly summarized. The procedure to be followed in "Operation Crossroads" is outlined. One B-29 will drop the bomb; parachute-suspended, pressure-recording instruments and blast gages will be dropped simultaneously with the actual bomb from higher altitudes by two B-29's; detailed photographs of every phase will be taken from eight B-29's and two C-54's; the air-instrumentation phases are to be accomplished by radio-controlled B-17's that will be flown into untenable areas at various periods after the explosion. Past experiments with radio-controlled heavy bombers are traced and present procedures are outlined. *Skyways*, May, 1946, pages 52, 53, 88, 90, 6 illus.; "Task Group 1.5," S. Ralph Cohen, *National Aeronautics*, April, 1946, pages 9–12, 17, 4 illus.

Avigation

Rendezvous at Sunrise. James H. S. Billmyer. Two simple methods of determining the position and time of sunrise while flying a straight course are presented. A graphic method is explained and also illustrated in diagrams. An equally quick and easy method, solved mathematically by proportion, is described. The almost negligible error introduced by the use of a Mercator projection is discussed. An *American Nautical Almanac* is the only additional equipment needed. *United States Naval Institute Proceedings*, February, 1946, pages 246–249, 3 illus.

Use of the Bubble Sextant. E. F. Flint. The advantages of the AN-5854 bubble sextant are reported, accompanied by a discussion of the basic principles of celestial navigation. Graphs are presented demonstrating the method of obtaining individual sextant error and the correct method of plotting a fix using the H.O. 218 solution. This solution is preferred by the writer because of its speed and comparative accuracy. Using the median of 15 accurate sextant observations is advocated. The new features incorporated in the AN5854 are listed. *Aero Digest*, April, 1946, pages 48–50, 117, 5 illus.

Bearings

Ball and Taper Roller Bearings. M. S. Frenkel. This analytic treatment gives general considerations concerning "true rolling" of a rolling body in a circular path: first, for constant speeds of its center of gravity and second, for acceleration of its center of gravity. From these are derived the relations of the dimensions, as functions of the conditions, and the corresponding constructions for both taper roller bearings and ball bearings, which are essential to produce "true rolling" at constant and variable shaft speeds.

In the case of taper roller bearings, it is shown that the center of gravity of a roller must be in a specified position for true rolling to take place, this position being nearer the smaller end of the conical rolling surface than the larger end, in contrast to present constructions. Some constructions satisfying the above conditions are described.

For angular-contact ball bearings, the relations of the dimensions de-

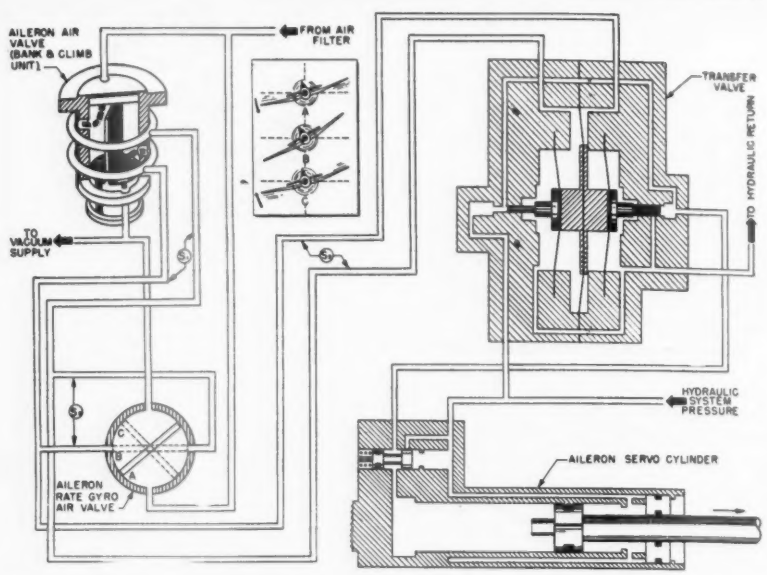
rived include those of the track grooves. Allowance is made for the fact that, in general, load distribution on the rolling bodies is extremely uneven, and constructions according to the relations of the dimensions are given which provide load distribution. *The Journal of The Royal Aeronautical Society*, March, 1946, pages 199–236, 16 illus.

Business and Finance

Know Where Those Dollars Are. Part III. Charles A. Parker. Suggestions are made in the third of a series of articles for the establishment and operation of a simple but efficient accounting system for the airport operator who carries on the business of student instruction, charter, sightseeing and rental flying, and the sale of aircraft and supplies. The records are kept in a set of eight books, each of which is explained with respect to the methods of bookkeeping employed and the functions performed by such records in reflecting the financial progress of the enterprise. Definitions are given of the classifications to which various items of income and expenditure are assigned, with instructions for charging or crediting them and for drawing up trial balances and financial statements. Sample sheets from the books are reproduced. *Aviation*, April, 1946, pages 46–49, 5 illus.

Airport Insurance—A Must. Frank X. Mara. An article recommending airport liability and other forms of insurance explains the kinds of insurance protection needed by the airport operator and the reasons for each. Past accidents are cited as examples of the need for insurance coverage and possible causes of claims for damages are enumerated. *Airports*, April, 1946, pages 42, 43, 58, 2 illus.

Investment Trusts See Worthy Future in Aviation Securities. Raymond L. Hoadley. The policies of large investment trusts and other investment companies with respect to the ownership of securities of aircraft-manufacturing and air-transport companies are surveyed. It is stated that the confidence of such corporate investors is evidenced by their holdings of an aggregate market value of about $28,250,000 of aeronautical stocks at the end of 1945. Comments are made about the amounts of aviation investments held by various companies, the ratio of such stocks to the total portfolios, and the diversification of capital funds among the stocks of aircraft-manufacturing companies, suppliers of equipment, and air lines. One table shows the amount and market value of air-line and aircraft stocks held by investment trusts on December 31, 1945, and another table lists the purchases and sales of stocks of air lines and manufacturing companies by investment trusts during 1945. *Aviation*, April, 1946, pages 53, 151.



A schematic drawing of the method of operation of the Grumman GR-1 automatic pilot when the aircraft's right wing is down.

Civil Aviation

Be Your Own Pilot! Joe Rainey Manion. This article predicts a great increase in private flying and includes information concerning procedure for taking private lessons and forming cooperative flying clubs. A list of representative aircraft offered for private sale under the direction of the War Surplus Aircraft Bureau is supplied, including type, number of hours of engine use, horsepower, and O.P.A. ceiling prices. Four primary trainers, one glider, and two of the larger types of airplane are listed. *Log of Navigation and Aviation*, May, 1946, pages 6, 7, 1 illus.

Profit in Insect Control by Aircraft. Ken Tyler. Suggestions are made concerning the use of aircraft in the work of crop dusting and related agricultural services. A crop duster, with 17 years of experience, describes his operating procedures and advises newcomers in the business. Pollenization of orchards and crops is cited as a potentially fast-growing enterprise. A converted N3N airplane is used because of its maneuverability, low cost, and ease of conversion. Prices of equipment are quoted. *Airports*, April, 1946, pages 18, 19, 5 illus.

Poacher Patrol. C. Budd Dugan. A feature article describes the duties of flying game wardens in Alaska, who use light airplanes in their work. It includes information concerning flying hazards in that territory, types of aircraft used, and unusual expedients employed, such as using moose fat and bear grease instead of oil. In the winter most of the airplanes are mounted on skis and can be used on snow, ice, or mud. *Flying*, May, 1946, pages 70, 71, 92, 94, 4 illus.

Control Equipment

The Application of Established Automatic Control Methods to the Study of Basic Flight Problems. Orin B. Johnston and John M. Anderson. The use of automatic controls in flight testing inspires a new approach to the study of the basic flight problems. Their use makes it possible to record data heretofore unobtainable. The controls themselves improve the performance characteristics of the aircraft. They also ensure ability to repeat test data, thereby making possible truly scientific results. Actual flight testing is the final measure of aeronautical development progress. Precise results are difficult to obtain because of the number and type of variables influencing the data. Testing is usually divided into three major categories: performance, stability and control, and structural tests. These categories are interdependent.

Definition of the operating characteristics of the aircraft requires a study of the basic flight problems. Such a study also outlines the requirements of automatic controls for satisfactory operation. These controls as applied to aircraft are discussed under two headings—power plant and stability. Since automatic control parameters are based on flight performance, they are an invaluable flight-test tool. Their use in flight testing results in several advantages: crew relief; stable, dynamic, and integrated control of variables; evaluation of automatic control; and economy. Specific examples of their use in actual tests demonstrate the results that are possible, including the promise of data for the determination of the dynamic constants in the equations of

flight. *Journal of the Aeronautical Sciences*, May, 1946, pages 235–246, 258, 10 illus.

Power-Assisted Controls. Principles of the construction and the method of operation of a recent device for power-assisting a pilot's controls are explained and illustrated. The Synchromo electric assister, designed and manufactured by B. and P. Swift Ltd., of London, is fitted to the Short Shetland flying boat and has many other applications where accurate proportional control is required. The device is so designed as to give the pilot the sense of "feeling the controls" yet requires the pilot to exert only one-sixth of the physical effort needed to operate the controls manually. *Aircraft Production*, April, 1946, pages 176, 177, 4 illus.

Push-Button Flight. A brief description is given of the Automatic Flight Controller, developed and test-flown in a C-54 by Air Matériel Command engineers at Wright Field, with two pictures illustrating the instrument. The aircraft is taxied into take-off position and a button is pushed. It is stated that complete take-off, climb, level flight, descent, and landing operations are accomplished by the preset Automatic Flight Controller and radio range station. *Southern Flight*, April, 1946, page 56, 3 illus.

Wider Operating Scope Attained by New Automatic Pilot. Raymond N. Greif. A new type of automatic pilot, recently introduced by the Grumman Aircraft Engineering Corporation, is described. The writer states that this unit, which is designated as GR-1, is being successfully flown on several leading Army and Navy combat aircraft. It is explained that it was rushed to completion toward the end of the war to fill the need for a lightweight, simple, automatic flight device for fighting aircraft, but in its present form it is readily adaptable for use on peacetime commercial aircraft. The unit is a self-synchronous, maneuvering automatic pilot. Automatic synchronization is a continuous adjustment relative to the position of the airplane, assuring continuation of the plane's flight attitude at the moment of engagement of the automatic pilot. Thus, the necessity for adjusting knobs or setting dials before engaging the automatic flight equipment, which is necessary on prevalent types, has been completely eliminated. Diagrams and photographs reveal design details of the new unit. *Aviation*, April, 1946, pages 68–72, 4 illus.

On the Method of Van Der Pol and Its Application to Non-Linear Control Problems. B. V. Bulgakov. The paper deals with the construction of approximate differential equations of a mechanical or electrical pseudo-linear oscillating system with many degrees of freedom. These equations must be applicable to the study of transitory or quasi-periodic processes, rather than to periodic vibrations alone. Equations for the latter were derived by the writer in an article published in the *Journal of The Franklin Institute* for June, 1943. The important case of an automatically controlled system is chosen as an example and made the object of a special investigation. *Journal of The Franklin Institute*, January, 1946, pages 31–54, 3 illus.

Deicing

De-Icing for To-day. The T.K.S. system of protection against icing by the use of fluids is considered to be an improved version of the Dunlop system. It is the new deicing equipment being fitted to the majority of British civil transports. The initials are derived from the names Tecalemit, Kilfost, and Sheepsbridge Stokes. Although the basic principle is the same as in the older model, the methods of distribution and regulation are improved. Two major problems overcome in the development of the T.K.S. system are the regulation of flow at the surfaces, enabling fluid to reach all essential points quickly and yet not be wasted, and that of initial regulation for different conditions. The fluid is described as being a compound of alcohol, glycerin, glycol, and glucose. The three different "standards" of deicing control are explained as to function and operation. *Flight*, April 11, 1946, pages 364, 365, 1 illus.

Design

Design of Magnesium Castings for High Properties and Soundness. C. J. McDowall. The advantages and disadvantages of castings made from the magnesium alloys are stated. Particulars are supplied about the proportions, properties, and basic factors that must be considered to assure sound castings of the desired strength and stiffness. The writer warns designers against going to extremes in minimizing casting dimensions to achieve lightness. He states that magnesium parts may have somewhat thicker sections, larger fillets, and even added stiffening ribs, and still be appreciably lighter than castings made of other metals. Because of the low elastic modulus and high tensile strength, magnesium parts must be designed with far more attention to strains and deflections than parts made of other materials. Some typical examples of well-designed magnesium-alloy castings are illustrated. *Product Engineering*, April, 1946, pages 340–343, 8 illus.

Aircraft Lines Development. George M. Kelley, Jr. A new lofting technique for aircraft design is presented. It was developed in the engineering department of the de Havilland Aircraft of Canada, Ltd., to ensure positive lines description for the transverse section and absolute progression from one point to another section. Particulars are supplied about the lofting of a fuselage, using a fully symmetrical section whose quadrant is described in terms of the radius. Advantages of the method are summarized. *Aircraft and Airport*, March, 1946, pages 23, 24, 69, 4 illus.

Flight Control Standardization. C. G. Peterson. Lack of standardization in the manufacture of component parts of aircraft is noted and the need for such standardization is discussed. The writer points out that the cockpit, more than any other portion of the airplane, needs standardization. The space allotment in the interior of aircraft, always a major design problem, is cited as another component in need of attention. A thorough description of the standard control column, designed by Tison Bros., is presented with explanatory diagrams. *Aero Digest*, April, 1946, pages 82, 83, 104, 3 illus.

Efficiency of Aircraft. Victor A. Ivanoff. The writer refers to the difficulty of finding a formula for the computation of aircraft efficiency which is suitable for making a simple and reliable comparison of modern aircraft of complex design. He then presents a method in which the mechanical work done by an aircraft in carrying a useful pay load or disposable load for military aircraft is compared with the quantity of B.t.u. of the spent fuel, by the application of the mechanical equivalent of heat. This work is then compared with a theoretically possible maximum. *American Helicopter*, April, 1946, pages 14–16, 1 illus.

Skyraider's High Performance Stems from Pin-Point Designing. Part I. E. H. Heinemann. Because of the many inquiries regarding the reasons for design arrangements in the Douglas BT2D-1 Skyraider, the Chief Engineer of the El Segundo plant of Douglas Aircraft Company, Inc., explains the design thinking behind the project. In a two-part article of which this is the first installment, it is related that the Skyraider was conceived in June, 1944, when it was found necessary to develop a modern single-place, long-range, high-performance dive bomber of much greater striking power than the prewar-designed two-place dive bombers then in service, such as the Douglas BTD dive bomber. The new requirements established for the BT2D are compared with the BTD. Information is supplied about means that were taken to reduce weight, increase lift, and achieve greater simplicity in design. Examples of what was accomplished by simplification and careful arrangement are illustrated, and summarized in a table of comparative design factors. *Aviation*, April, 1946, pages 55–58, 7 illus.

Electrical Equipment

Electronically Balanced Recorder for Flight Testing and Spectroscopy.

A. J. Williams, Jr., W. R. Clark, and R. E. Tarpley. Details are supplied about a multiple-point potentiometer recorder for thermocouples. The writers refer to a previous paper that described the application of the electronically balanced recorder in potentiometer form to the measurement of 140 thermocouple temperatures during flight tests of airplanes. They explain that interest in the recorder for other uses, such as wind-tunnel testing, turbine checking at sea, and, in modified forms, for spectroscopy, is the reason for this paper on the recorder itself.

Sections of the paper deal with mechanical construction, filter circuits, method of damping, and other features.

Two recorders developed for use in spectroscopy also are described. The first of these is a curve-drawing multiple-range microampere recorder with the smallest range 0.5 microampere, and with a balancing time of less than 1.0 sec. The second is a multiple-range current-ratio recorder requiring only about 10 microamperes for the reference current. *Electrical Engineering*, April, 1946, pages 205–208 (Transactions), 10 illus.

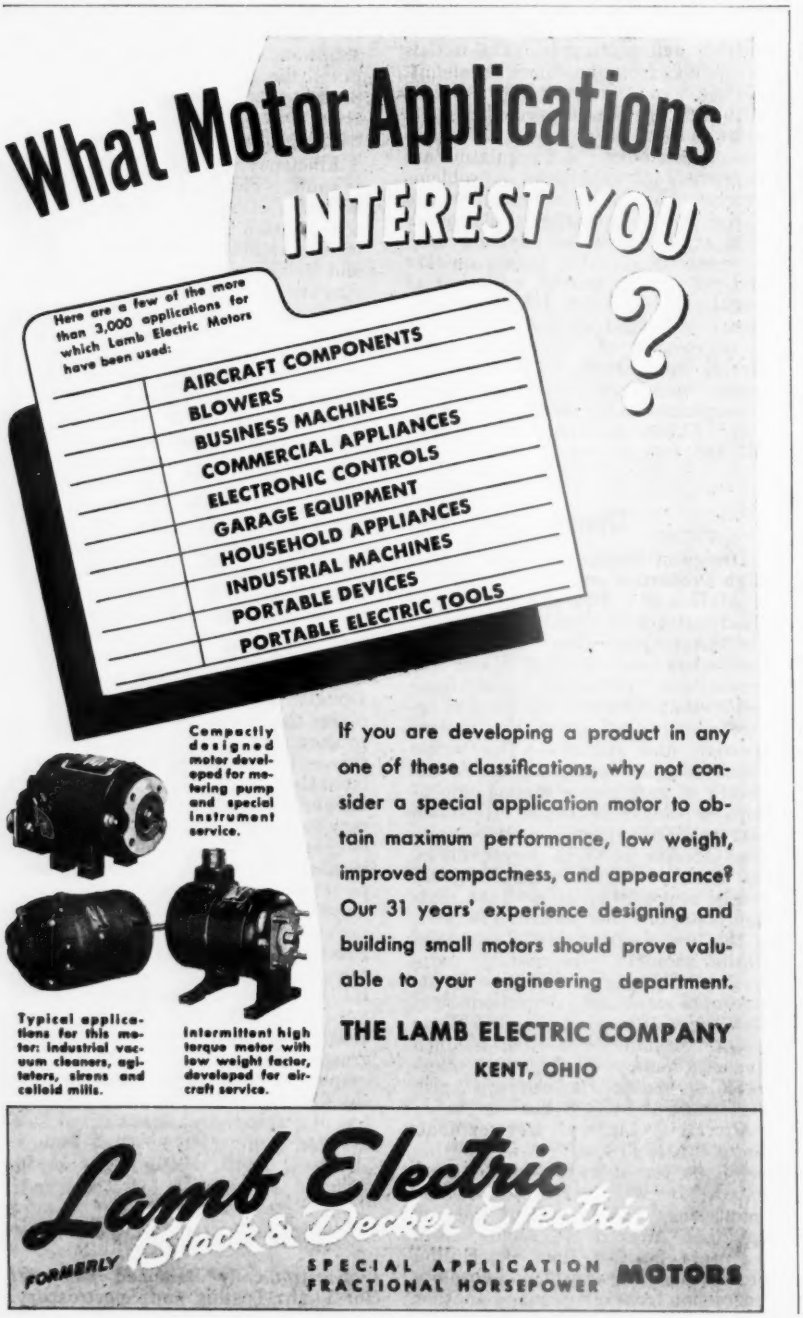
The Standard Wiring System for Aircraft. F. Emsley. Further particulars about the standard wiring system that has been approved by the British Ministry of Aircraft Production are supplied in the conclusion of a two-part article. The fundamental requirements of an electrical installation for aircraft are set forth. Sections discuss the earth-return system, standard wiring components, and the heavy-duty junction of the busbar type. Conclusions from the study are presented. *Aircraft Engineering*, March, 1946, pages 97–102, 10 illus.

Electronics

Shoran Precision Radar. Stuart William Seeley. Shoran, designated by the Army as AN/APN-3 and AN/-CPN-2, is used for high-precision position-finding in aerial navigation, principally for "blind" bombing and aerial mapping. Shoran is generally credited with being the most precise system of its type. The history of the conception and development of the principles employed, as well as a description of the physical make-up of the equipment, are disclosed following recent declassification from the lists of military secrets.

Through the medium of television experiments in 1938, it became evident that linear distance could be measured by means of high-frequency radio waves timed from transmission to point of reception or by timing the round trip. A short pulse length could be transmitted and returned from a receiver-transmitter and the distance determined within ±50 ft.

The Shoran system requires two ground stations (transmitting on approximately 310 megacycles) and a receiver-transmitter in the aircraft (from 220 to 260 megacycles). The aircraft equipment transmits a series of short pulses of radio-frequency energy to each of a pair of ground stations. These in turn immediately retransmit the received signals to the plane, where the round-trip transmission time is measured in terms of distance. Shoran coordinates of the bombing target are determined before hand, keeping in mind that the distance from a ground station to a plane several thousand feet over a target can differ as much as $^1/_{10}$ mile from the distance over the earth's surface to the target. With this information determined and Shoran distances from each ground station to the point over the target preset, the plane flies in either direction on an arc centered at one of the ground stations. The radius of the arc is equal to the station-to-target distance. One pair of ground stations can serve a large number of planes bombing widely separated targets simultaneously, because of the short bursts of transmission and long pauses in the interim. The returned impulses from both stations are computed automatically into station-to-target distances in miles and decimal portions of a mile, on dials instead of the usual Vernier-scale cathode-ray tube. The antenna for radiating the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transmitter power is of the stub type and is mounted vertically either above or below the fuselage. An attempt is made to produce as nearly an omnidirectional pattern of vertically polarized radiation as possible.

The ground installation consists of four principle units, the receiver-monitor, the transmitter, the antenna arrays, and the gasoline-driven power supply. The complete equipment is transportable by air, and can be flown to a known location and put into operation within 90 min after arrival.

The use of "blind" Shoran bombing over the battlefields of Europe showed that it was capable of equalling visual bombing in accuracy under normal conditions and surpassing it when conditions imposed difficulties in the identification of targets. *Electrical Engineering*, April, 1946, pages 232–240 (Transactions), 12 illus.

History and Activities of the Radiation Laboratory of the Massachusetts Institute of Technology. L. A. DuBridge. A brief history and an account of the activities of the largest wartime laboratory devoted to radar research and development are given. The research carried on, the development of the war laboratory, manufacture of equipment, the field services accomplished, and the cooperation with the British and with other American scientific organizations are reviewed. The demobilization of the laboratory will release to universities and industries the talents of the scientists who worked there, and the benefits of their efforts will be available for peacetime use. *The Review of Scientific Instruments*, January, 1946, pages 1–5.

Aircraft Radar. Vin Zeluff. The writer describes the use and purpose of the following electronic navigational aids: Teleran, Ground Control Approach, Lanac, and Loran. While it is agreed that considerable developmental work will be necessary before radar techniques are widely applied to commercial aviation, they are expected to play an important part in the future of aerial navigation and aerial safety. *Scientific American*, May, 1946, pages 204–206, 4 illus.; "Television for Private Flying?" by Kurt Rand, *Flying*, May, 1946, pages 27–29, 105, 106, 6 illus.

Engines, Gas Turbine

Jet-Propulsion Gas Turbine. D. L. Mordell. The characteristics of the jet engine in relation to the aerodynamic and thermodynamic variables as power units are analyzed. The sea-level performance is shown as a function of the principal design variables, and the effects of forward speed and altitude on both the cycle thermodynamics and on the performance of a given unit are illustrated. The nature of jet propulsion is explained, and consideration is given to jet thrust and the propulsive efficiency of a jet. The characteristics of the Campini jet-propulsion system, for which the writer sees little future, and the Whittle system, are described and compared. A simplified mathematical analysis of the Whittle cycle applicable to all flight conditions is presented in an appendix. From the analysis it is concluded that the jet engine appears indispensable for fast aircraft because of its high power-to-weight ratio at high speeds, and because of its improving fuel consumption, since even at speeds of 400 m.p.h. the increased fuel consumption does not necessarily affect the range. Additional advantages of the jet engine are enumerated. *Aircraft Engineering*, March, 1946, pages 84–88, 6 illus.

Recent Developments in the Axial-Flow Blower. James G. Sawyer. Following a description of the status of the axial-flow blower in 1938, the writer outlines recent developments in this unit and discusses the design principles involved. Sections are devoted to the airfoil theory of fan design, the Wattendorf fan theory, the constant-pressure blower, the turbine-type fan, the turbine-type axial-flow compressor, and commercial blowers of the turbine type. *The Engineers' Digest*, February, 1946, pages 29–32, 7 illus.

Armstrong Siddeley Turbines. Construction and development of the Armstrong Siddeley A.S.X. and A.S.P. Python gas-turbine units are extensively examined and illustrated by photographs and diagrams. Although all the facts cannot be revealed concerning Python components and interior design, performance and fuel-consumption curves are reproduced. The main static and moving components of the A.S.X. are listed and the construction of the various parts is described. It has an axial-flow compressor and two-stage turbine. Data including dimensions, weights, and performance are presented in tabulated form for both the A.S.X. and the Python. *Flight*, April 4, 1946, pages 336–340, 11 illus.; "Jet Developments at Coventry," *The Aeroplane*, April 5, 1946, pages 393–395, 8 illus.

These Are the Turbines. David A. Anderton. The various types of gas turbines that have been developed in the United States, Great Britain, and Germany, including recent models, are reviewed and illustrated. Fundamental principles of gas-turbine operation are simply explained and the evolution of this type of aircraft power plant is reviewed. Attention is directed to factors influencing the efficiency of gas turbines. Diagrams reveal the construction of the early-type reverse-flow centrifugal turbojet engine, the straight-flow centrifugal turbojet engine, and the axial-flow type. The comparative sizes of a straight-flow centrifugal turbojet engine and a radial engine, and of an axial flow turbine and a liquid-cooled engine, are shown diagrammatically. The illustrations of gas turbines range from the original Whittle engine to recent Westinghouse and General Electric axial-flow models. A table contains the important specifications of American and foreign gas turbines. *Air Trails*, May, 1946, pages 24–27, 98–101, 21 illus.; "British Jet Engines," by Louis Bruchiss, *Air News*, April, 1946, pages 69–71, 13 illus.; "Comprehensive Chronology of British Turbo-Jet Developments," by John Foster, Jr., *Aviation*, April, 1946, pages 78–81, 6 illus.

Combustion in the Gas Turbine. D. G. Shepherd. The purpose of a two-part article is to outline certain of the special problems of gas-turbine combustion and to generalize some of the experience obtained in recent years. Following a brief review of the underlying principles of the gas turbine, the subjects treated in the first section are design of combustion chamber; combustion requirements; and efficiency of combustion. A graph records the variation of air and fuel flow at constant speed, at ground level and at 40,000 ft. Another graph deals with the variation of air pressure and temperature with engine speed, at ground level and at 40,000 ft. Schematic drawings show an annular combustion chamber (straight-flow type); a multiple combustion chamber (straight-flow type); and a multiple combustion chamber (return-flow type).

The second and concluding part of the article treats in detail the reliability of the gas turbine; carbon deposits; stability of combustion; ignition; temperature distribution; fuels and fuel injection; testing and development of combustion chambers; and future requirements. The writer anticipates great improvement in combustion-chamber design and states that, because of the better facilities for bench testing that are now available, advances will be more rapid than was the case in the development of reciprocating engines. *The Engineer*, March 22, 1946, pages 268, 269, 5 illus.; March 29, 1946, pages 300, 301.

Jet Propulsion Engines and Propeller Drive Gas Turbines—Their Application in Future Aviation. R. P. Kroon. Following a concise description of the operating principles and major design features of aircraft gas turbines, the writer evaluates the performance characteristics of jet engines and gas-turbine propeller drives, to determine how these power plants may be applied in future aviation. A considerable part of the article deals with fundamental principles but in this section some statements are interjected in reference to information that has been gained through research and experience. In comparing the relative advantages of the centrifugal and axial-flow types of gas turbine, the writer states that the axial-flow compressor seems to have a slight advantage in efficiency, but that the centrifugal compressor undoubtedly is less expensive to build and in small sizes may prove equal or

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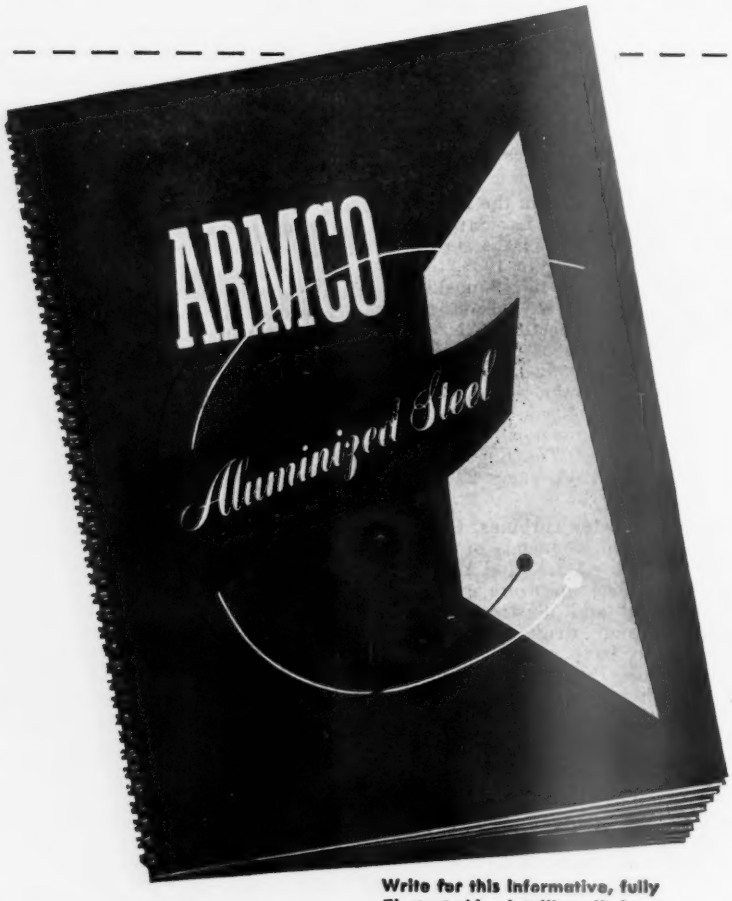

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superior in efficiency to the axial-flow compressor. German gas turbines are compared with those that have been produced in the United States. It is stated that their weights run from 1½ to 2 times as high as American-built gas turbines. Consideration is given to the flight characteristics of jet engines. The application of gas turbines in military and commercial aircraft is discussed. *Journal of The Franklin Institute*, March, 1946, pages 167–185, 18 illus.

A British Axial-Flow Turbo-Jet. The history and development of the Metropolitan-Vickers F.2 Series IV axial-flow turbojet engine are traced. After a brief review of the experience of the manufacturers with gas turbines, the cycle of operation of the gas turbine is outlined. The methods of cooling the turbine and its bearings, the lubricating system, and the fuel system are summarized. The procedure in starting the turbine is explained. A detailed discussion of the construction relates the experimental and developmental work carried out by the manufacturer with regard to the compressor, turbine blades, combustion chamber, and other components. Specifications of the unit are tabulated and two pages are given to a construction drawing showing the interior parts. *The Aeroplane*, March 8, 1946, pages 281–287, 12 illus.

Engines, Reciprocating

Some Experiences in Full-Scale Power-Plant Testing. Milton U. Clauser. With the increased engineering activity required by the war, it was necessary to cope with rapidly changing design requirements, many of which were unfamiliar even to experienced personnel. In order to gain experience more rapidly in the power-plant installation work, the Douglas Aircraft Company built and tested several full-scale engine installations. This paper traces the development of these test installations and the results that were obtained.

The first installation was a ground-test nacelle for the A-20 series airplanes. The severe cooling troubles later encountered on the airplane in flight were not anticipated from these ground tests; so on the next model, the A-26, the nacelle was tested in the N.A.C.A. 16-ft. high-speed wind tunnel at Langley Field. Although these tests and similar ones on the engine installation for the XSB2D-1 airplane were of considerable value, the experience that had been obtained up to this time was not considered to be sufficiently widespread.

The next nacelle installation was given extensive ground testing, with the designers participating in the running of the tests and the analysis of the data. The caliber of the design engineers upon completion of these tests was such that the succeeding airplane was designed almost without benefit of any type of test. The flight-test results on this airplane indicate that the experience of the designers enabled them to do an outstanding engineering job of producing a simple and reliable power-plant installation. *Journal of the Aeronautical Sciences*, May, 1946, pages 247–254, 7 illus.

Induction Ramming Effects in Single-Cylinder Four-Stroke Engines. L. J. Kastner. The paper describes a series of experiments carried out to determine how the fluctuations of pressure, which occur in the induction pipes of four-stroke engines, may be best employed to improve the charging of the engine cylinder. Two single-cylinder engines were used during the tests, the first being a medium-sized water-cooled unit running at speeds between 1,000 and 2,000 r.p.m.; the second, a smaller air-cooled engine capable of higher rotational speeds. The effects of changes in diameter and length of induction pipe were explored with both engines, the valve timing remaining fixed; and, using the water-cooled unit, extensive trials were carried out at three standard engine speeds to find what valve timing gave maximum air consumption for each of a number of induction pipe lengths. Finally, the influence of several sizes of carburetor venturi tubes in damping out the pressure fluctuations and reducing the ramming effect was investigated. Information is given, based on the results of the experiments, enabling a suitable length and diameter of induction ramming pipe to be chosen for engines running at any constant speed, as well as for those covering a wide range of speeds. The conclusions are summarized under six headings, and comments about other essentials regarding various parts of the paper are appended. *Proceedings of the Institution of Mechanical Engineers*, Vol. 153, No. 7, 1945, pages 206–214, 14 illus.

Rolls-Royce Griffon 65. Parts II and III. J. A. Oates. Part II in a series of articles on the Rolls-Royce Griffon 65 examines the machining operation on light-alloy components. These include the crankcase, cylinder head, reduction-gear case, and the supercharger casing. It is stated that, because of their shape, the marking-out of these parts would be a most difficult and laborious operation, in view of the number of awkwardly situated bores and faces which require machining, if this difficulty had not been completely overcome by the introduction of "spot location" fixtures, in which every casting is checked before leaving the foundry.

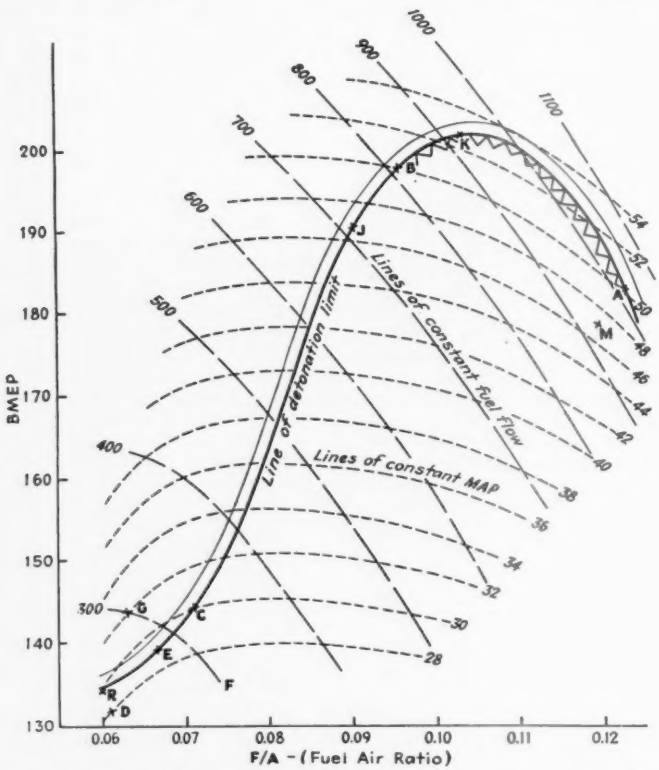
Examples are described and illustrated under the following headings: finish boring; front-end boring; six-bore pilot bracket; traverse bores; drilling operations; broaching; the cylinder head; intermediate reboring; and final boring. Other headings are profiling operations; the wheelcase; and indexing drilling fixture.

The third and concluding article deals mainly with the subassembly operations, the line assembly of the Breeze ignition harness, and final engine erection. A fixture designed for hand-reaming the seven bores in the front end of the crankcase and the reduction-gear case is described. The following topics are studied in detail: the crankcase; pressure testing; balancing the impeller unit; ignition-harness assembly; engine erection; and building sequence. A list of 43 operations of final erection of the Griffon 65 is given in sequence. *Aircraft Production*, March, 1946, pages 115–124, 24 illus.; April, 1946, pages 161–169, 23 illus.

The Monaco Engine. Brief descriptions of the new four-cylinder, horizontally opposed light-aircraft engines manufactured by the Monaco Motor and Engineering Company, Ltd., of Watford, England, in 75-hp. and 100-hp. sizes, are accompanied by illustrations of the 100-hp. unit. The engine has the conventional basic layout of its type but the makers state that accessibility and ease of maintenance have been stressed. Dimensions and construction details are included. The engines are intended for installation in the Chrislea Ace. *Flight*, March 14, 1946, page 264, 3 illus.; "A New British Light Aero-Motor," *The Aeroplane*, March 15, 1946, page 312, 4 illus.

Dynamic Loading and Some Indications of Its Effect on Internal Combustion Engines. Comdr. C. W. Chapman. The paper shows that when forces are applied to a mass that is connected to another mass by a stressed member, the "stressing forces" (i.e., the forces that must be considered when stressing the connecting member) are not the applied forces but are fluctuating forces comprising the applied forces modified by vibratory forces at the natural frequency of the system. The relative intensity of these vibratory forces depends upon the rate of application of the applied forces, and the period for which they are sustained, compared with the natural periodic times of the system to which the forces are applied. Formulas are given for assessing the "stressing" forces under different conditions of application of the applied forces, and a graphical method of obtaining "stressing" force curves corresponding to applied force curves is described. The application of the theory to some of the forces occurring in internal-combustion engines is illustrated by a series of curves. *Proceedings of the Institution of Mechanical Engineers*, Vol. 153, No. 7, 1945, pages 221–236, 36 illus.

Factors in Aeration and Deaeration of Aircraft-Engine Oil. W. L. Weeks. The writer offers some information about the cause of oil aeration in airplane engines which has been gained through a protracted investigation and test program conducted by the Wright Aeronautical Corporation. It is revealed that scavenger pumps are not solely responsible for oil aeration. The oil fed to these pumps was found to contain 6 to 20 per cent of finely



A chart of brake-mean effective pressure versus fuel-air ratios for a particular engine speed obtained by Pan American engineers in attempting to achieve more economical operation for transport aircraft. The chart shows a typical mixture-response curve, with lines of constant fuel flow and constant absolute manifold pressure superimposed on it.

divided air. The writer concludes that entrained air is inherent in engines with integral reduction-drive gears, supercharger drives, and multiple accessory drives. It is stated that the practice of handicapping deaeration with low operating oil temperatures and localized oil flow through tanks as imposed by the conventional hopper should be discontinued. With these restraints to deaeration removed, it will probably be found unnecessary to add accessory operating devices to the power-plant oil system in most cases, although several such devices or means have been or can be developed. *SAE Journal*, April, 1946, pages 174–190 (Transactions), 28 illus.

How Flight Detonation Testing Keys Engine-Fuel Performance. Robert J. Clark and Richard M. Adams. A system for gathering and interpolating essential data on aircraft fuel and engine detonation under actual flight conditions is described. It was developed by engineers of Pan American Airways for the purpose of achieving better economies and greater pay loads for transport aircraft. Flight detonation tests were carried out on Clippers, safe economy being the end sought. The writers explain the theory behind the work done and describe how the tests were developed and carried out. *Aviation*, April, 1946, pages 63–67, 6 illus.

Gliding and Soaring

Sailplanes for Hire. This article reports the existence of two civilian sailplane fields in Southern California, operated by two former Army sailplane instructors, using surplus Army and Navy training craft purchased from the Government. Passenger flying and week-end instruction are providing a lucrative business. The sailplanes operating from Rosamond Dry Lake are launched by means of towing by a 235-hp. Duesenberg automobile. The San Diego field operates with a Stearman tow plane. The Southern California Soaring Society plans a series of sailplane contests during the summer season either in the Bakersfield vicinity or at Twenty-Nine Palms. *Skyways*, May, 1946, pages 44, 45, 4 illus.

Plain Sailing? The present need for improved sailplanes for the armed services and civilian use is investigated. Details are presented of two new sailplanes, the T.M.2 and the "Wanderlust." The T.M.2 is a shoulder-wing cantilever monoplane with a modern low-drag wing section having a constant thickness-chord ratio of 16 per cent from root to tip and 2° "washout" on the outer third of the span. Dive brakes are fitted to insure a low diving speed. The Wanderlust is a wooden cantilever shoulder-wing monoplane. The wing is a single box spar situated at 33 per cent of chord and the nose has a plywood skin extending back to the spar. Specifications are supplied, including the wing loadings, weights, and performance. *The Aeroplane*, March 8, 1946, pages 299, 300, 4 illus.

History

A Short History of the Development of Airplane Structures. N. J. Hoff. Basic trends in the development of airplane structures are reviewed in a two-part article, of which this is the first installment. The article is confined to airplanes other than rotating wing types. Discussing the reasons for the structural forms of airplanes, the writer shows that these forms are not incidental but are the consequences of the properties of the materials used in their construction; of the state of knowledge of structural theory and aerodynamics at the time they were built; and of the economic, social, and political implications of their use. Considering the connection between functional design and beauty, he observes that in the slow evolution of an architectural style through centuries all unsuitable features arising from incorrect use of the materials, misunderstanding of the laws of statics, or personal whims of the individual architect are eliminated. Tracing the evolution of structural form, in this installment he reviews the early period of airplane construction, which is considered to extend from the beginning of the century to the outbreak of the first World War; and the wood-steel-fabric biplane era extending from 1914 to 1922. *American Scientist*, April, 1946, pages 212–225, 12 illus.

Inspection

Fluoroscopy of Light-Alloy Castings. B. Cassen and D. S. Clark. The significance of fluoroscopically observed defects in light alloy castings with regard to the strength characteristics and usability of the castings is studied. The use of higher X-ray voltages to obtain greater screen brightness is discussed. Information also is supplied about the examination of steel castings at voltages from 140 kv. to 200 kv. The article supplements a previous one on the subject published in *The Iron Age*, November 1, 1945 (AERONAUTICAL ENGINEERING REVIEW, January, 1946, page 65.) *The Iron Age*, April 18, 1946, pages 48–50, 3 illus.

Classification and Inspection of Castings for Airplanes. M. A. Melcon. A new plan for the quality control of castings for airplanes, developed by the Lockheed Aircraft Corporation, is described. For purposes of inspection and acceptance, castings are classified solely according to the function of the part in the airplane. It is explained that the method insures maximum inspection of all castings vital to the safety of the airplane or its oc-

cupants. A table of vital castings that comprise Class I is shown. Castings that may or may not be important, but are not vital to the airplane or its occupants, are placed in Class II. Methods of designating radiographic inspection requirements after the castings have been classified are described. *Automotive and Aviation Industries*, April 1, 1946, pages 40, 85.

Instruments

Auditory Signals for Instrument Flying. T. W. Forbes. With a view toward the development of auditory means for conveying instrument indications to the pilot, to relieve his eyes of a part of the responsibility of watching instruments, a study of auditory flight indications was made and the results are reported. The purposes of the study were to determine (1) what types of auditory signals could be followed with greatest ease; (2) with what accuracy such signals could be utilized; and (3) how many simultaneous auditory signals could be followed successfully. It was therefore necessary, first, to design a variety of different auditory signals and, secondly, to test their effectiveness on a group of men in a task similar to that of "flying blind" in an airplane.

The development of various types of auditory signals is traced, and their operation and the test methods are explained. The results indicate that, if the signals are properly designed, as many as four auditory indications can be followed without interfering with radio and interphone communication when occasion demands. *Journal of the Aeronautical Sciences*, May, 1946, pages 255–258, 5 illus.

Flight Test of Astrobine. J. C. Cable. A brief description of the Astro-Bine, its functions, and its first test in flight, is given by the inventor. The general appearance of the instrument is said to resemble a combined sextant and astrocompass. The inventor explains the operation procedure as follows: two stars are observed simultaneously 20 times; a record of average position in terms of latitude and local hour angle for the mean time of observations is obtained from a set of tables; and the coordinates of the fix are plotted. The results of the experiment, using the third experimental model of the Astro-Bine, produced an average error of only $8'/_{11}$ miles. *Log of Navigation and Aviation*, May, 1946, pages 17, 18, 4 illus.

The Development of a New Wind-Measuring System. Louvan E. Wood. A new lightweight anemometer and wind vane with associated equipment is described. Designed primarily for fixed station and marine use, it is also suitable where portability is required. The characteristics of pitot-static, bridled, cup-wheel, and propeller types of anemometers are reviewed and reasons for using a propeller in the new equipment are stated. According to the writer, the new instrument is characterized by accuracy, linearity, and generally excellent performance as determined by wind-tunnel and other tests. The anemometer is adaptable to wind-speed measurement by means of magneto and voltmeter, disc and roller tachometer mechanism, contacts, or electronic devices. *The Bulletin of the American Meteorological Society*, November, 1945, pages 361–370, 7 illus.

New Four-Band ADF. Allen Scott. A description is given and advantages are outlined of the new AN/ARN-6 automatic direction finder, developed by Fairchild Camera & Instrument Corporation. The improvements enumerated are as follows: weight reduced to 60 lbs.; a fourth band (100 to 200 kc.) incorporated, thereby permitting the use of European and Asiatic range stations; designed to withstand high-altitude effects, tropical deterioration, and high humidity without change of electrical characteristics because of hermetically sealed parts; and the new loop control circuit, reported to give a bearing accuracy within 1°. *Air Transport*, April, 1946, pages 67, 68, 71, 3 illus.

Lightplane Instruments. Esther Forbes. Types, quality, and price of light-plane instruments are investigated. The writer reports on the products of the Aeromarine Instrument Company and states that the types are the same as those manufactured before the war, although they are considerably improved and the prewar prices have not been altered. Price ranges and sensitivity of instruments conform to the standards set by the price and size of the aircraft for which the instruments are designed. It is stated that improved instruments will be on the market soon. *Southern Flight*, April, 1946, pages 32, 33, 4 illus.

Towards Safer Flying. British experimental work undertaken in an attempt to find the right solution to simple navigation and all-weather operations is reviewed. The Chairman and Director of an aeronautical research corporation has had a Lockheed 12A equipped with the following equipment: an M.F. H.F. 40-watt Bendix T.A. 12c transmitter and associated R.A. 19 receiver; blind-approach equipment for operation with Lorenz apparatus; a Bendix automatic radio compass; A V.H.F. type 1464 two-way radio telephone; and a Decca Navigator, all remotely controlled from the pilot's cockpit. The equipment weighs between 200 and 350 lbs. Its installation and use are outlined. Other new equipment is discussed briefly. *The Aeroplane*, March 29, 1946, pages 376–378, 10 illus.

Landing Gear

Landing Gear Strength Envelopes. J. F. McBrearty and D. C. Hill. A method is outlined for constructing

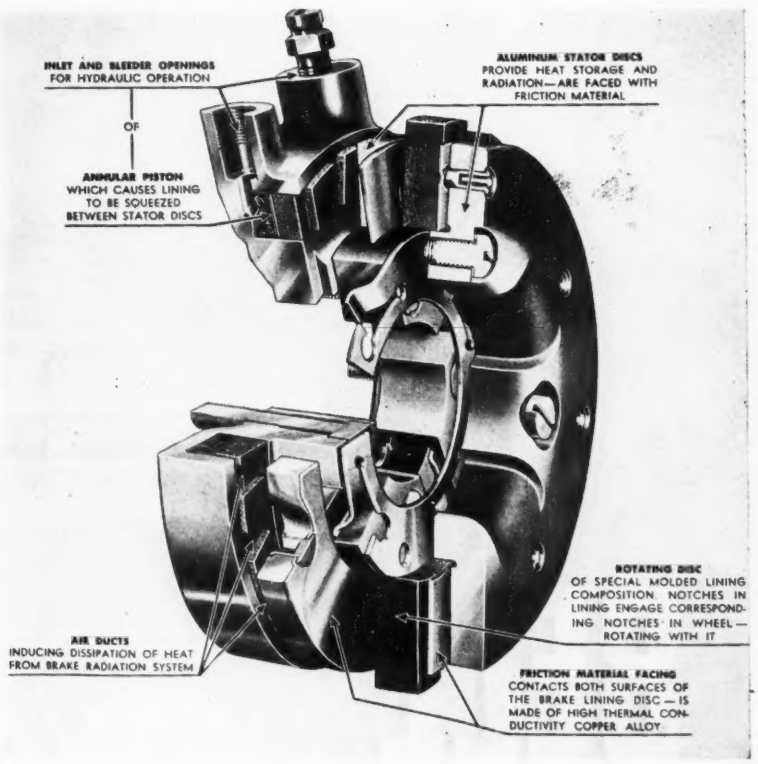
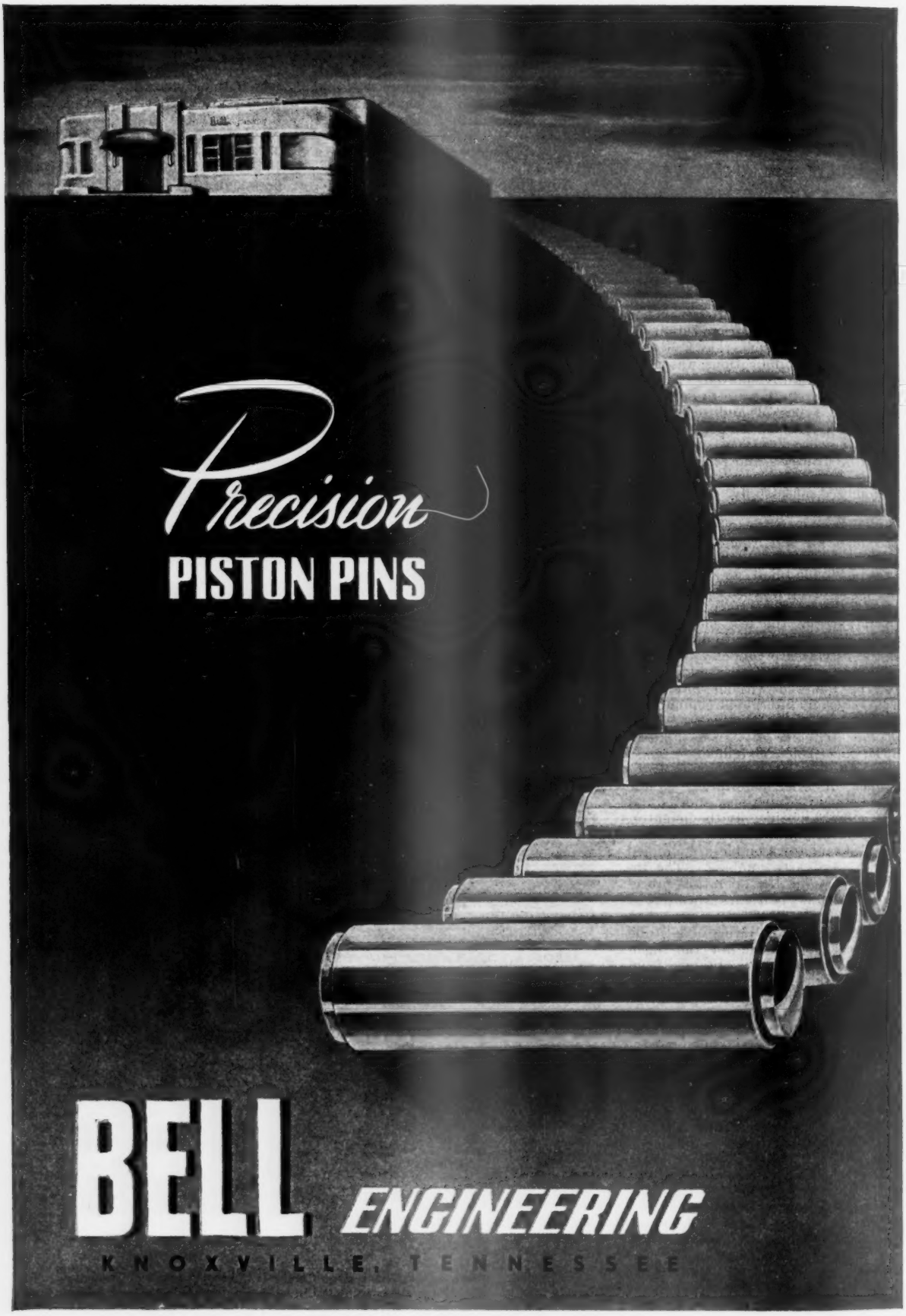

INLET AND BLEEDER OPENINGS FOR HYDRAULIC OPERATION
OR
ANNULAR PISTON WHICH CAUSES LINING TO BE SQUEEZED BETWEEN STATOR DISCS
ALUMINUM STATOR DISCS PROVIDE HEAT STORAGE AND RADIATION—ARE FACED WITH FRICTION MATERIAL
ROTATING DISC OF SPECIAL MOLDED LINING COMPOSITION. NOTCHES IN LINING ENGAGE CORRESPONDING NOTCHES IN WHEEL—ROTATING WITH IT
AIR DUCTS INDUCING DISSIPATION OF HEAT FROM BRAKE RADIATION SYSTEM
FRICTION MATERIAL FACING CONTACTS BOTH SURFACES OF THE BRAKE LINING DISC—IS MADE OF HIGH THERMAL CONDUCTIVITY COPPER ALLOY

Illustration Courtesy Firestone Tire & Rubber Company

The operation of the new Firestone aircraft brake is illustrated in this cutaway view. Extremely low operating temperatures are stated to be made possible by using fabricated stator discs for extra heat-storage capacity.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diagrams illustrating the strength of landing-gear structures for various combinations of loads. The diagrams show graphically the maximum combinations of vertical-drag and vertical-side loads which a landing gear can sustain without failure. Strength diagrams for several different airplanes are presented and their significance is discussed.

The charts facilitate a comparison of landing-gear strengths, are useful in determining the effect of physical changes to the gear structure, and are helpful in the derivation of suitable ground-load strength requirements. *Journal of the Aeronautical Sciences*, May, 1946, pages 229–234, 12 illus.

Roadability and Landing Ability in Aircraft Undercarriages. Reinhardt M. Rosenberg. Generally, undercarriages are designed for absorbing landing shocks and for achieving stability in take-offs, landings, and against overturning. As more interest in roadable airplanes is shown, ride comfort in ground travel should also become an important design consideration.

In this paper, expressions are derived (from the standpoint of ride comfort) for front and rear axle location and for spring stiffnesses and damping coefficients of front and rear. It is shown that an undercarriage, designed for ride comfort only, is unsatisfactory in landings unless (1) the lengths of spring and damper strokes differ; (2) the damper possesses two damping coefficients—i.e., selective orifices, one to be used in ground travel and the other for landings; and (3) the center of gravity of the ground vehicle is appreciably further forward than that of the airplane in flight attitude.

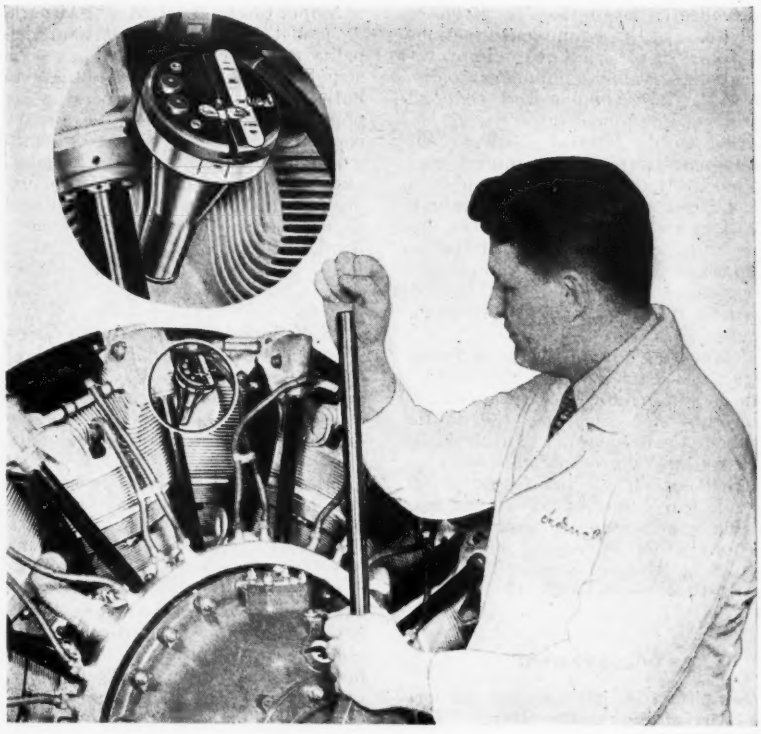
The last requirement is necessary for longitudinal stability in take-off runs and may be achieved by disposing of, or by suitable storing on the craft, wings and tail assembly. The equations are applied to a particular (fictitious) airplane.

The development presented introduces the general problem. However, the treatment is considerably simplified by omitting tire flexibility and a number of degrees of freedom. No attempt has been made to render judgment as to the worth of roadable airplanes. *Journal of the Aeronautical Sciences*, May, 1946, pages 270–276, 5 illus.

Lighter-Than-Air

Captain Slate's Wonderful Airship. Frank B. Howe. What is described as the first all-metal dirigible ever to be constructed and floated through the air without damage from expansion or contraction of the outer covering is stated to have been completed in 1929 by Capt. Thomas B. Slate. An account is given of the design and construction of the airship and its "jet-like" propulsion method. A high-speed centrifugal compressor, driven by a radial engine, was located in the center of the nose. Its operation created a partial vacuum ahead of the craft, and the air stream then flowed back over the area of the largest diameter of the tapered hull and created additional thrust. The inventor stated that the action of these forces overcame the retarding effect of air resistance and resulted in driving the craft forward by both pull and push. Another feature was an elevator for lowering passengers to the ground while still aloft, and for rescue work.

The airship was never flown in full-scale form but it is stated that a model was tested in the wind tunnel at New York University and performed successfully. The airship itself was wrecked just before a test flight in California because the mechanics failed to set the automatic pressure valves on the gas bags as the ship was being taken from the hangar into hot sunshine and the sudden expansion of the hydrogen caused the seams of the duralumin envelope to burst open. *Flying*, May, 1946, pages 61, 62, 102, 103, 4 illus.



Photograph Courtesy Gabb Manufacturing Company

Precision engine timing by direct measurement of piston travel is provided by a new device designed for timing operations on all reciprocating-type aircraft engines. A slide pointer and an adjustable calibrated scale eliminate the need for finding top dead center and compensate for the variables involved in accurate positioning. The instrument may also be used for magneto-point synchronization.

Lubrication

Aircraft Engine Oil Cooling. Frank Nixon. An extensive study is made of the cooling of the lubricating oil of engines installed in aircraft. The opening section of the article outlines the need for oil cooling, the magnitude of quantities involved, and methods of cooling adopted in the past. The theory of cooling and oil-temperature regulation then is explained sufficiently to convey a working understanding of the problem and current practice is described. The causes and cure of the troubles that have been experienced are dealt with at some length, and the final section is devoted to the most recent developments and probable future trends.

The allied subjects of engine lubrication systems, aircraft oil systems, oil-tank design, deaeration, and oil dilution, with altitude effects and operation at low temperatures, are brought in where they concern the main topic of cooling. It is stated that they are worthy of a separate study, which it is hoped will be made before they have been rendered obsolete, or at any rate less important, by the general adoption of turbine power units. *The Journal of The Royal Aeronautical Society*, March, 1946, pages 123–198, 58 illus.

Maintenance

Servicing Equipment for Civil Aviation. Patrick Macartney. Attention is called to the importance of the wide range of useful but unspectacular equipment on which depends much of the success or failure of a modern air line to run safe, comfortable, and regular services, and obtain the absolute maximum of utilization from its air-

craft fleet. Examples are given of how some of this equipment functions in these services. Future improvements in servicing equipment are discussed. It is emphasized that all servicing equipment must be mechanized to the utmost, both to cut down man-hours to the minimum and to ensure that the aircraft spends the least possible time on the ground. Sections are devoted to built-in equipment, delivery-pump characteristics, oil tanks, cabin problems, compressed air systems, and the planning of stores layouts. *Aeronautics*, April, 1946, pages 75, 76, 78.

Recovering the Light Plane Fuselage. Ed Packer. The article contains a step-by-step description of the procedure for renewing the fabric cover on the fuselage of a light airplane. Illustrations show how this work is carried out on a Piper Cub trainer. Details are supplied about cutting, fitting, and "doping" canvas, and various other operations and techniques. *Aviation Service Magazine*, April, 1946, pages 16–25, 41, 20 illus.

Management

Simplified Accounting for Airport and Aircraft Service Operators. Todd Mumma. The requirements for an accounting system for airport and aircraft-service operations are stated. It is explained that such an accounting system must be simple in operation and still produce detailed and effective results. An accounting system developed to meet these requirements is partly illustrated by the presentation of certain source records, which include a flight ticket, general sales ticket, and lines sales ticket. *Aviation Maintenance & Operations*, April, 1946, pages 34, 35, 1 illus.

Accounting Can Be Simple! J. F. Robinson. Accounting practices and simplified methods of keeping accurate business records are suggested for the benefit of operators of airports serving private fliers and other types of air traffic. A "packaged" accounting system using inexpensive portable and counter-type machines for handling records of all transactions is recommended, with suggestions for the preparation of printed forms to facilitate the bookkeeping and office work. *Airports*, April, 1946, pages 22–24, 4 illus.

Peacetime Cost Estimating Requires New Learning Curves. Gardner W. Carr. A cost engineer explains why present cost figures cannot be logically related to wartime figures, which, he shows, can be misleading under today's conditions. He reviews the factors that affect costs, such as production volume, tooling, design of components for efficient manufacture, and the cost in man-hours of teaching inexperienced personnel. He weighs the varying factors that must be considered as the aviation industry enters a new era of keen commercial competition. *Aviation*, April, 1946, pages 76, 77, 1 illus.

Model Contract for Model Airpark. A "model" contract between a municipality and an operator-manager of an airport is suggested. Advantages to both the city and the operator are pointed out. Control of the airpark is retained by the city's airpark board, which has the responsibility of determining general policies, future improvements to the airpark, and fitness of commercial operators. *Airports*, April, 1946, page 49, 1 illus.

Marketing

"Self-Serve" Display Builds Sales. The visual-merchandising plan evolved by The Goodyear Tire & Rubber Company as an aid to dealers in setting up or modernizing airport retail stores is outlined. A distributor or dealer desiring to establish a retail store or to improve an existing layout sends a sketch to the company's visual-merchandising laboratories, where a careful analysis is made and recommendations are offered in complete detail. Standardized fixtures and equipment are arranged under three general plans, according to the available space and the amount of the financial investment contemplated, designated as the Economy, Special, or Standard plan, and numerous variations and combinations can be made to fit the particular conditions. The service includes advice with regard to external and internal store design, layout, fixtures, packaging, display, and sales promotion. Consultation, drawings, and other services are rendered without charge to the dealer, the company's objective being the promotion of markets for all kinds of supplies and accessories for private aircraft and is not limited to the sale of the company's aeronautical products. *Airports*, April, 1946, pages 20, 21, 4 illus.

Materials

Magnesium Alloys for Aircraft. Part I. F. A. Rappleyea. A comparison of the use of magnesium alloys with the commonly used aircraft structural materials is made in the first of a series of articles. Inasmuch as weight reduction results in such pronounced benefits, the differences in cost between currently available materials of high and moderately high specific strength are relatively unimportant. The comparison is made not only on the basis of the fundamental principles of design, but also compares the actual structures, referring in general to the commonly used 24S-T aluminum alloy. However, all the new, high-strength aluminum alloys, such as Alclad 75S-T, R301-T, and various steels are considered in the comparison of fundamental design principles.

A formula for determining the buckling strength for both sharply curved sheet and slightly curved sheet is supplied and explained. A table lists the minimum properties of 20 alloys. A graph records the prewar magnesium production in the United States and a table shows the ratio of weight factors of structural metals based on Dowmetal C-HTA. *Aero Digest*, April, 1946, pages 79–81, 2 illus.

Medicine

Scientific Medicine in Aviation. Thomas H. Sutherland. The writer expresses his objections to the change in the physical-examination procedure for private fliers which permits the examination to be performed by any licensed doctor of medicine. Reasons are stated why flight permits should be issued only by physicians who are qualified and equipped for the service. *The Journal of Aviation Medicine*, February, 1946, pages 104–106.

Human Factors in the Visual Examination of Aviators. Comdr. Benjamin J. Wolpaw. Referring to the change in the physical-examination procedure for private fliers which permits the examination to be performed by any licensed doctor of medicine, the writer makes a plea for the continuance of the trained examiner as against merely any doctor of medicine. Some of the human factors and a few of the pitfalls to be encountered in carrying out the visual examination are reviewed. *The Journal of Aviation Medicine*, February, 1946, pages 100–103.

Physical Fitness and Age of Army Air Forces Personnel. Peter V. Karpovich and Lt. Earl L. Green. It is noted that physical fitness is affected by age but, while in the very young and very old this can be observed easily, in the age range of Army Air Forces' personnel this relationship is often obscured by constitutional characteristics and by variations in the amounts of physical training received by different individuals. Reasons why a better knowledge of the relationship between physical fitness and age is of practical importance are stated. Particulars are supplied about an investigation conducted in eleven A.A.F. installations to meet the immediate need of the physical training instructors and to prepare reference graphs showing the relationship between age and performance for all items used in the A.A.F. physical-fitness test. *The Journal of Aviation Medicine*, February, 1946, pages 96–99, 1 illus.

Safety and Aircraft Design. Lt. Col. Richard H. Follis, Jr. For several years the Medical Safety Division of the Army Air Forces has been concerned with aircraft design as it affects personnel involved in accidents

occurring in flight and on the ground. The writer reviews some of the principles that have been learned. Examples of designs that cause accidents include a case where the landing gear and flap controls were placed too close together; a case where poor ventilation caused excessive cockpit temperatures; and the use of upper escape hatches. Various problems connected with designing aircraft for safety are discussed. *The Journal of Aviation Medicine*, February, 1946, pages 92–95.

Occurrence of Decompression Sickness on Descent from High Altitudes. Capt. Simon Rodbard. Because chokes and neurologic disturbances may occur during or after descent from an altitude of 30,000 ft., that is, at altitudes where bends and chokes ordinarily disappear, an analysis was made to gain a better understanding of these paradoxical symptoms. Six cases in which the paradoxical occurrence of chokes during descent from simulated high altitudes were observed are described and analyzed. The investigation was carried out at Hq. 1, Troop Carrier Command, Stout Field, Indianapolis. *The Journal of Aviation Medicine*, February, 1946, pages 89–91.

Environmental Temperature and Swing Sickness. Major Allan Hemingway. In an investigation of the effect of temperature on motion sickness, conducted at the A.A.F. School of Aviation Medicine, Randolph Field, Tex., 971 subjects were given a swing test in outdoor environments where temperatures ranged from 0° to 40°C. No significant difference in the incidence of swing sickness in cold or warm environments was found. It is concluded that the apparent beneficial effect of cool air on motion sickness is probably subjective and is caused by the apparent relief of uncomfortable and unpleasant sensations during motion sickness. *The Journal of Aviation Medicine*, February, 1946, pages 86–88, 99, 1 illus.

The Relationship of Air Sickness to Other Types of Motion Sickness. Major Allan Hemingway. In an investigation conducted at the A.A.F. School of Aviation Medicine, Randolph Field, Tex., the incidence of various types of motion sickness such as carsickness, seasickness, trainsickness, and sickness on amusement park devices was obtained for approximately 1,500 men in the A.A.F. whose airsickness history was known. Each man was given a swing test. The groups varied in airsickness susceptibility from airsick eliminees to fliers who had never been airsick. The incidence of swing sickness characterized by vomiting was 11.3 per cent for the nonairsick fliers and 64.4 per cent for airsick eliminees. The usefulness of the swing test and a history of motion sickness for selection of fliers is discussed. *The Journal of Aviation Medicine*, February, 1946, pages 80–85, 95, 3 illus.

A Study of the Brain After Intermittent Exposure to a Simulated Altitude of 23,000 Feet. William F. Windle and Arthur V. Jensen. The study reported was undertaken to determine possible effects on nerve cells of exposure to tolerably low partial pressures of oxygen intermittently over relatively long periods of time. It was carried out at the Institute of Neurology, Northwestern University Medical School, Chicago. Young adult male guinea pigs were subjected to a simulated altitude of 23,000 ft. 6 hours a day for 6 days a week until they had accumulated totals of 100, 200, 300, and 500 hours in a decompression chamber. At appropriate periods experimental animals and controls were sacrificed. Careful comparison of sections through the brains of experimental animals and controls revealed no hemorrhages, vascular changes, or glia proliferation. No cytological alterations in nerve cells could be found. Inspection revealed no reduction in the number of nerve cells, and no changes in the myclin sheaths of nerve fibers or abnormalities in the fiber tracts of the brain. *The Journal of Aviation Medicine*, February, 1946, pages 70–79, 4 illus.

Aviation Psychiatry. Capt. E. L. Caveny. The psychiatric problem in aviation is treated as a responsibility of the flight surgeon. The writer points out that the need for aviation psychiatry arises from circumstances not unlike those which led to the development of the now recognized branches of psychiatry—that is, special problems arising in a fairly specific group of individuals who are engaged in similar activities in a relatively uniform environment. Aviation offers numerous psychiatric problems peculiar to itself. It is stated that the specific problems encountered arise from two cardinal factors, the personality of the individual in aviation, and the environment in which that personality is placed. The flight surgeon is taught to be concerned primarily with these two factors. How psychiatric disturbances characteristic of aviation are understood when consideration is given to flight personnel and to the nature of their highly specialized duties is described. It is stated that the objective of training in aviation psychiatry is to instruct the flight surgeon to appreciate the importance and meaning of the actions, reactions, and attitudes of the individuals with whom he associates. *The Military Surgeon*, April, 1946, pages 289–292.

Incidence of Bends Pain in a Short Exposure to Simulated Altitudes of 26,000, 28,000, and 30,000 Feet. Comdr. H. A. Smedal, Lt. (j.g.) E. B. Brown, Jr., and Lt. (j.g.) C. E. Hoffman. A total of 1,731 flight students were exposed to simulated altitudes of 26,000, 28,000, and 30,000 ft. for 20 min. at either room temperature or very low temperature, with approximately one-half of the subjects on each "flight" exercising at 3-min. intervals. The investigation was carried out at the Altitude Training Unit, School of Aviation Medicine, Naval Air Training Bases, Pensacola, Fla. Among exercising subjects there was found to be a higher incidence of bends under warm conditions. *The Journal of Aviation Medicine*, February, 1946, pages 67–69, 79, 1 illus.

The Effects of Cold and Rate of Ascent on Aero-Embolism. D. R. Griffin, S. Robinson, H. S. Belding, R. C. Darling, and E. S. Turrell. The main purpose of the reported experiments, which were made in the Fatigue Laboratory of Harvard University, Soldiers Field, Boston, was to study the relationship between body temperature and the incidence of bends. Subjects were exposed to simulated ascents in a refrigerated altitude chamber. The test procedure and results of the investigation are described. It was found that men kept comfortably warm suffered significantly less from joint bends than they did when they were definitely cold. Partial protection from joint bends was achieved either when the experiments were conducted in warm air (about 80°F.) or when the subjects wore adequate electrically heated clothing. Heavy alpaca clothing, without electrical heat, did not reduce the incidence of bends significantly from the rate found in the same subjects when definitely cold. *The Journal of Aviation Medicine*, February, 1946, pages 56–66, 2 illus.

Altitude Pain. Franklin M. Henry. A report is made of a study of individual differences in susceptibility to bends, chokes, and related symptoms, conducted by the Department of Physical Education, University of California. A total of 1,412 man-flights were made under one or another of ten different decompression-chamber flight conditions ranging from 30,000 to 38,000 ft. in altitude, and varying in amount and type of muscular activity. Following the report rather extensive conclusions are presented. Some of these are: individual differences appear to be best accounted for by a systemic rather than local-specific theory of susceptibility; degree of motor impairment is highly correlated with pain intensity experienced in a particular limb; individual differences in susceptibility are maintained for weeks or months; susceptibility is best measured by symptom intensity scores; the prophylactic effects of preoxygenation are gained at the expense of lost time, of preselection at the expense of lost man power. Emphasis on one or the other may be indicated by conditions, but effective prophylaxis requires recourse to both. Curves show the effectiveness of preselection in reducing decompression sickness. *The Journal of Aviation Medicine*, February, 1946, pages 28–55, 10 illus.

The Oculo-Gyral Illusion. Capt. Ashton Graybiel and Ensign Dorothy I. Hupp. An investigation of the oculo-gyral illusion, a form of apparent motion which may be observed

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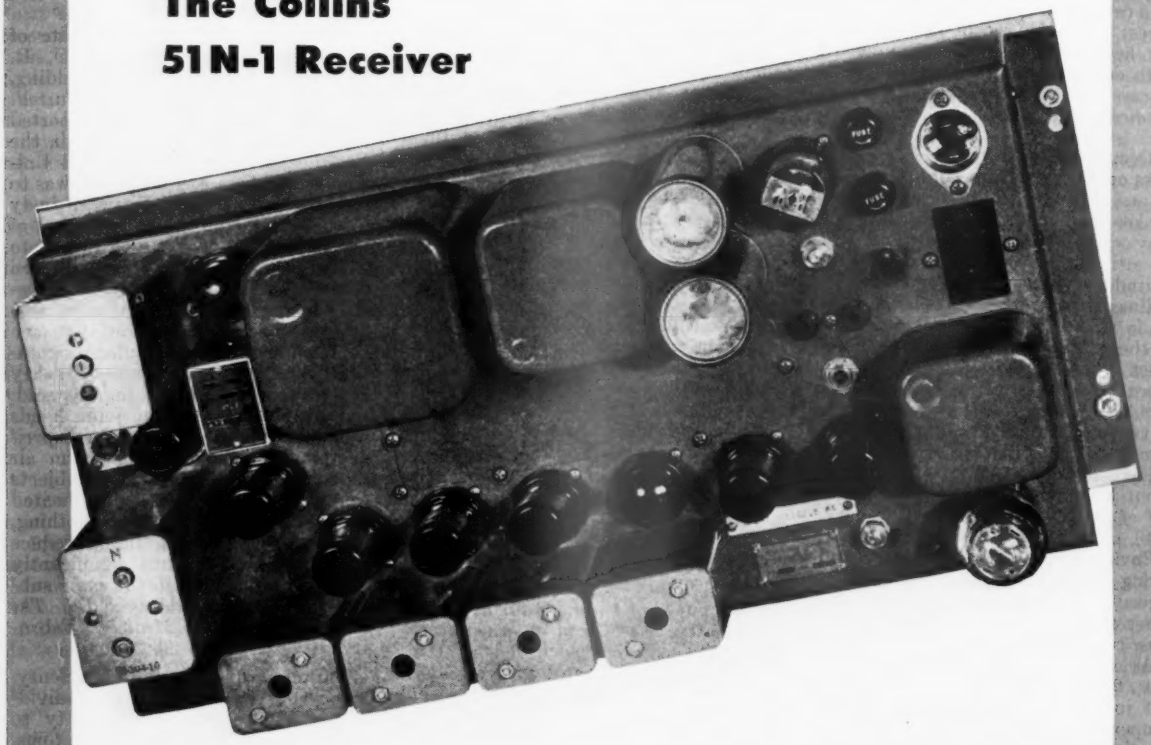

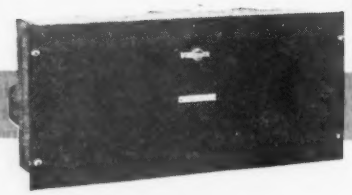

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COLLINS

following stimulation of the semicircular canals, is reported. It was carried out at the School of Aviation Medicine, U.S. Naval Air Training Bases, Pensacola, Fla. Human subjects were rotated in a modified Link Trainer, in a Barany chair, or on a human centrifuge, under controlled laboratory conditions, and the illusory perceptions of motion were recorded. Some of the tests were carried out in a lighted room but the majority were carried out in a dark room. The chief variables introduced in the experiments concerned the nature or illumination of the fixation object, the direction and strength of the stimulus, and the position of the head of the subject. The experiments are briefly discussed from the standpoint of the advantages of the method employed, the results obtained, and the practical application, particularly with respect to flying. *The Journal of Aviation Medicine*, February, 1946, pages 3–27, 2 illus.

Metallurgy

Rapid Method for the Photometric Determination of Iron in Aluminum Alloys. Michael S. Pepi. Because methods for the determination of the iron content in aluminum alloys were slow and required skill on the part of the chemist, an investigation was carried out which led to the development of the rapid photogrammetric method described in this article. The method is based on the reaction of 1,10-phenanthroline and iron. Research developments leading to the introduction of the new method are described. Equations show the chemical reactions occurring in this method. The method is compared with previous methods of determining the iron concentration in aluminum alloys. *Aluminum and Magnesium*, March, 1946, pages 12, 13, 20, 21, 2 illus.

Importance and Factors Determining the Grain Size of Magnesium Castings. L. W. Eastwood and James A. Davis. The effects of pouring temperature and section thickness on the grain size of magnesium-alloy castings are discussed with particular reference to an investigation carried out at the Battelle Memorial Institute. Four magnesium casting alloys were tested. The results of the tests are tabulated. It is concluded that the grain size of light sections of magnesium castings, perhaps up to $^3/_8$-in. thick, is substantially unaffected by pouring temperature over a range of 1,500° to 1,300°F. In some instances, a pouring temperature of 1,250°F. causes an increase in grain size. Where solidification is slow, or in heavier sections, the grain size is markedly increased with increasing pouring temperature, the finest grains being obtained at a pouring temperature of about 1,300°F. Coarse grain tends to accentuate microporosity slightly, and extremely slight increases in grain size are accompanied by a markedly increased susceptibility to hot cracking. *Aluminum and Magnesium*, March, 1946, pages 14–17, 1 illus.

Meteorology

The Relationship Between Sea-Level and 10,000-Foot Zonal Westerlies. Lt. Harry L. Wynn. A formula is set forth and explained for obtaining consistency between the sea-level and the 10,000-ft. zonal westerly indexes, employed in extended forecasting of changes in weather conditions. The result is useful in arriving at a forecast of the two indexes which will be consistent; second, to infer from observed pairs of indexes the departure from normal of the potential energy of the atmosphere. A simple graph may be constructed by this formula for adjusting toward consistency. Testing reveals that index forecasts are improved by this technique. *The Bulletin of the American Meteorological Society*, November, 1945, page 384.

Weather Network. The prewar weather-forecasting system is described and the developments brought about during the war, as well as postwar plans, are related. With existing weather stations in foreign countries being turned over to the foreign governments, a survey is made of new permanent stations in this country and outlying possessions. The writer refers to the Arctops Project, an attempt being made by the Massachusetts Institute of Technology to bring American knowledge of the Arctic up to date. Present meteorological equipment is explained under the following topics: (1) The radiosonde—consisting of radio equipment carried aloft by a balloon to send down information concerning pressure, humidity, and temperature. (2) Rason—the same as radiosonde with the addition of a radio compass device for determining the elevation and azimuth of the balloon. This provides wind-direction and velocity data above the clouds. (3) Radar—which is particularly helpful at night, in revealing thunderstorms and even large raindrops over a radius of 75 to 150 miles. However, the equipment is considered too expensive to be installed on a large scale. (4) The ceilometer—a photoelectric device for measuring cloud heights by scanning a vertical beam of light with a photoelectric cell and noting the angle of elevation at the point where the reflection from the cloud is found. (5) The spectrophotometer—which determines the amount of weather vapor in a vertical column of atmosphere. (6) Weather reconnaissance by aircraft—considered by the writer to be the most spectacular of all recent developments. Plans for a new electronic calculator were recently submitted to weather officials. It is reported to offer some far-reaching possibilities for long-range forecasting. *National Aeronautics*, April, 1946, pages 18–20, 2 illus.

Military Aviation

The Future of the Army Air Forces. Gen. Carl Spaatz. After paying tribute to the accomplishments of the Army Air Forces under the leadership of General Arnold, General Spaatz discusses the mission of the A.A.F. in peacetime and various phases of the requirements necessary for its accomplishment. Emphasis is placed on the importance of maintaining an Air-Force-in-Being of adequate size and proper composition, strategically deployed, and in a high and constant state of readiness. It is stated that it must be supported by a well-balanced, forward-looking program of research and technical development; by an alert, readily expandable aeronautical industry; and by an informed and enlightened public opinion. The program for the internal organization of the A.A.F. is outlined. The extent to which the advance of air power depends on scientific research and industrial planning is emphasized. *U. S. Air Services*, April, 1946, pages 10–13, 2 illus.; "The Future of the Army Air Forces," by Gen. Carl Spaatz, *Air News*, April, 1946, pages 17–20, 22, 85, 6 illus.

Our Wrecked Air Forces. Fred Hamlin. The statistical findings of a survey on demobilization of Air Force equipment are presented. Proposals of A.A.F. planners for an active peacetime air force are reviewed. The feasibility of an active National Guard, consisting of 87 squadrons, is considered. It is the writer's belief that if this question of an adequate aerial defense is not answered soon, a postwar Army air force of any worth will have to be completely rebuilt at additional cost to the taxpayer and at the risk of permanent peril to national security. *Flying*, May, 1946, pages 24–26, 4 illus.

A Survey of Military Air Transport. Group Capt. P. S. Foss. In a paper read before the Southern Section of the Institute of Transport the writer surveys the history and outlines the broad structure of the British Transport Command's air routes and air-route operations. He also touches on the subject of transport support. *The Journal of the Institute of Transport*, February-March, 1946, pages 239–244.

The Middle East. Parts I, II, and III. Air Commodore J. L. Vachell. The Middle East Command of the R.A.F. is considered the center of British air power overseas because of the ease with which reinforcements could be dispatched in any direction. Subdivisions of the Command are briefly described in the first part of the article. The Command's responsibilities extend from Casablanca in Morocco in the West to Iran in the East, and from Austria to East Africa and the Seychelles Islands. Present functions and locations of various groups in the Command are revealed.

Transportation is at present the chief function of the R.A.F. in the Mediterranean-Middle East Com-

mand although most of the responsibility for air transport in the Middle East is borne by Transport Command, with the 216th Group in charge of administration and operations. The staging posts on the main air routes are now used almost entirely for civil and R.A.F. transport services. Main air routes used by the transport command and the air lines are outlined. Internal transport services have been reduced to 25 per cent of the total and will be further reduced in the future. The 216th Group at present is responsible for providing aircraft for the training of the 6th Airborne Division, stationed at Palestine, but the writer feels that British Overseas Airways Corporation should assume responsibility for the main air routes and that the Transport Command should then be absolved of internal service duties in the Middle East and of training the 6th Airborne Division.

In the concluding article the writer discusses the influence that the union of Arab states might have on the position of Great Britain and the R.A.F. The situation in general is reviewed and it is suggested that the main base for the R.A.F. in the Middle East might be moved south of Arabia. The writer feels that the Middle East is likely to become an important theater of operations if there should be another war. *The Aeroplane*, March 22, 1946, pages 338, 339, 1 illus.; March 29, 1946, page 369, 1 illus.; April 5, 1946, page 397, 1 illus.

Paints and Coatings

Hard Surfacing Light Metals. W. C. Reid. The article describes a method by which aluminum and magnesium alloys can be easily and inexpensively hard-surfaced to any required depth with such metals as carbon steels, stainless steels, nickel, Monel, Nichrome, the bronze alloys, and, for certain bearing conditions, with babbitt. It is stated that the same metallizing equipment used for many other purposes can be employed for this process. Types of guns particularly suitable for this type of application are described. *Modern Metals*, April, 1946, pages 6, 7, 2 illus.

Personalities

Aviation Profile of Dr. Edward P. Warner. An outline of the career of the President of the Provisional International Civil Aviation Organization is presented in an article reviewing his part in aviation and his past experience in the field. He is described as one of the oustanding authorities of the world on the economic and technical aspects of transport aviation. *International Aviation Journal*, April, 1946, page 23, 1 illus.

General "Tooey." James Lee. An informal sketch of the life and military career of the Commanding General of the Army Air Forces emphasizes incidents of a human-interest nature. Anecdotes of humorous happenings are mingled with stories of his flying exploits and important military accomplishments. *Flying*, May, 1946, pages 32, 33, 96, 98, 3 illus.

Diehard Designer: Vincent Burnelli. Ben H. Bagdikian. In this biographic sketch the career of Vincent J. Burnelli is traced. Following a review of his early life and education, the writer describes his activities in the field of aviation, with particular reference to those connected with the flying wing and the lifting fuselage. Illustrations and drawings of Burnelli's designs of aircraft are shown. *Flying Age*, May, 1946, pages 28, 29, 44–47, 8 illus.

Britain's Test Pilots. Parts I through IV. The first of a series of articles featuring the backgrounds and achievements of British test pilots introduces Capt. Cyril R. Uwins, Chief Test Pilot of Bristol Aeroplane Company, Ltd. Captain Uwins has flown 58 genuine prototype aircraft and has 4,400 hours of flying time. Episodes in his work are related, especially his test flying of Bristol fighters and engines at high altitudes, and his peacetime contributions to the development of commercial aircraft.

The experiences of Capt. H. S. Broad, Senior Production Test Pilot of Hawker Aircraft Company, are related in the second of this series of biographic sketches. With more than 7,500 hours of flying time to his credit, Captain Broad has flown 182 separate types of aircraft. He learned to fly in 1915, at the Hall School of Flying at Hendon.

The third test pilot whose career is reviewed is Group Capt. P. W. S. Bulman. After extensive service with the Royal Flying Corps and the Royal Air Force during World War I, and the Royal Aircraft Establishment after 1918, he joined the Hawker company. Starting with the Heron and Hornbill, he was responsible for test-flying all the Hawker prototypes, including the Hurricane. Bulman was Chief of the Test Branch of the British Air Commission in the United States in 1941 and flew all the types of aircraft ordered for the British Government. Several of his outstanding achievements are recounted.

J. L. Lankester-Parker began flying in 1913. He became Chief Test Pilot for Short Brothers in 1918 and has made all the first flights on new Short types from the Shirl up to the Shetland. With about 5,000 hours of flying to his credit, he has retired as test pilot and is now sales director of the company. *Flight*, March 21, 1946, pages 288, 289, 5 illus.; March 28, 1946, pages 314, 315, 5 illus.; April 4, 1946, pages 332, 333, 6 illus.; April 11, 1946, pages 368–370, 6 illus.

Photography

Colored Trace Oscillograms. L. S. Trimble and F. W. Bowden. It is noted that a convenient method of studying a function that changes rapidly with time is to convert it to an electrical impulse and record the corresponding variation by means of an oscillograph. In many cases several light beams are caused to record on the same photosensitive material, and often these beams will be simultaneously deflected so that trace entanglement results, making the final study of an individual line practically impossible. This condition is accentuated in aircraft flight-test recordings where, because of space and weight considerations, as many as twelve oscillating traces are recorded on a 6-in. width of photographic paper. An illustration shows an entanglement resulting from flight stresses in a Lockheed 60-passenger, high-speed Constellation. The writer describes how aerial Kodacolor has been found suitable as a cure for trace-entangled illegible oscillographic records. He states that film $5\frac{1}{2}$ in. wide, used in combination with filtered light beams, is productive of distinctly differing color traces at recorded speeds up to 20 in. per sec. *Journal of the Society of Motion Picture Engineers*, March, 1946, pages 231–236, 4 illus.

Photography in Proving Ground Command of AAF. Lt. Ira S. Glick. An account is given of the part played by photography in the proof-testing of A.A.F. combat equipment and tactics at Eglin Field, Fla. The organization and development of this proving ground are described, and details are given about the photographic equipment and methods used in connection with proof-testing. *U. S. Air Services*, April, 1946, pages 24, 25, 32, 1 illus.

Specialized Photography Applied to Engineering in the Army Air Forces. P. M. Thomas and C. H. Coles. The article outlines how high-speed motion pictures, high-speed still pictures, special recording devices, and color pictures are being used in the design and engineering program of the A.A.F. To provide an idea of the way photography is applied toward the solution of aircraft problems, the organization of the Photographic Engineering Branch of the Technical Data Laboratory, Engineering Division, at Wright Field, is described. *Journal of the Society of Motion Picture Engineers*, March, 1946, pages 220–230, 1 illus.

Air Survey and Special Air Charter. H. Hemming. The writer discusses the part air survey and special air charter operations will play in economic development, with particular attention to the British Empire. It is stated that the air camera has completely revolutionized surveying by extending survey operations still further into the field of economic development, while aircraft designed for heavy freight lifting will enable mineral and oil deposits in areas difficult of access to be tested and developed. The opinion is expressed that there is considerable scope and a bright future in air survey and special air charter operations for a limited number of specialist contractors. *Aeronautics*, April, 1946, pages 36, 37.

Plants

Underground Factories in Italy. M. G. O. A brief description of two underground factories that produced aircraft engines and parts in Italy reveals the approximate location, the amount of space, and the extent of the work performed in the systems of tunnels. *The Aeroplane,* March 29, 1946, pages 370, 371, 3 illus.

Plastics and Plywood

Plastics and Plywood in a Private Plane. The application of plastics and plywood to the production of a plane designed to fulfill the requirements for personal flying is described. The article has particular reference to the construction of the Culver Model V resin-bonded plywood plane. It is stated that this airplane was designed as a result of the experience gained in the manufacture of radio-controlled high-speed target planes during the last war. How the poplar plywood fuselage and wings are formed, and how the plastics are applied to nonstructural parts, is explained. *Modern Plastics,* April, 1946, pages 158–160, 7 illus.

Private Flying

Let's Be Realistic About Private Flying. William T. Piper. The President of Piper Aircraft Corporation appraises private flying in a realistic manner, based on the facts as they exist at present. It is believed that private flying will become the "poor man's" transportation in due time, but gradual development will be necessary. The writer does not recommend roadable planes of speeds of 200 m.p.h. because of fuel costs; or tricycle landing gear on light planes. It is his opinion that turf landing strips are satisfactory for the early stages of airport development if they are designed for all-direction take-off and landing "into the wind." Extravagance in the construction of airports should be avoided. Changes in design of light airplanes will not be as revolutionary as has been predicted, nor will prices compare with the cost of automobiles in the near future. Comments are made about proposed research programs in the light-plane field, prevention of accidents, and the need for more terminal facilities for private planes. *Flying,* May, 1946, pages 21, 119, 120, 122.

What One Businessman Wants in His Personal Aircraft. A Canadian businessman, who travels both locally and over long distances in connection with his work, describes the qualifications an airplane should have to fulfill his business and pleasure requirements. A high-wing, twin-engined monoplane, with a single tail unit, four seats, a retractable tricycle landing gear, cruising speed of at least 150 m.p.h., and a range of 4 hours are his requisites. The airplane must be convertible to skis or floats. Reasons for these stipulations are given in detail. *Aircraft and Airport,* February, 1946, pages 22, 24, 46, 1 illus.

Your Private Ticket for $100. Russ Brinkley. Directions are offered and the various steps are explained for forming a flying club. Probable expenditures, methods of organization, and plans for operation are listed. Among the topical questions answered are: Who may organize a flying club? How may prospective members be obtained? How can such a group be brought together? What should be done at the first meeting? What to do next? *Southern Flight,* April, 1946, pages 34, 64, 65, 1 illus.

Production

Experiences with Carbide-Tipped Tools. M. E. Feldstein. The application of carbide-tipped cutters and tools in the plant of the Delco Products Division of the General Motors Corporation is described. The purpose of the method was to aid in furthering the war effort by achieving greater production with fewer people and fewer pieces of equipment. One of the major problems was the machining of landing-gear struts for aircraft. To obtain a solution to the problem of getting more production per machine-hour, a study was made of all aspects of carbide-tool application. Information is supplied about the results of the study and the system of tool controls developed. *Mechanical Engineering,* April, 1946, pages 307–313, 16 illus.

Chlorination Procedure and Equipment for Treating Magnesium-Base Alloys. W. C. Newhams. Part I of a two-part article describes chlorination procedure for gas porosity in magnesium-base alloys for aircraft castings. It is noted that investigation has shown that the gas in solution in the liquid metal, which is precipitated during the freezing process and causes voids in the solid metal, is hydrogen resulting from the decomposition of water. Reference is made to melting control work directed toward the prevention of water from contacting the molten metal. It is stated that, in order to eliminate the gas porosity from the melts and insure essentially gas-free metal at the mold, it has been more satisfactory to resort to the alternative of removing the gas from the molten metal before pouring. The chlorination procedure and equipment for carrying it out are presented in detail. *Aluminum and Magnesium,* April, 1946, pages 14–17, 3 illus.

Eliminating Brittleness in Aluminum-Silicon-Bronze Hydraulic Sleeves for Aircraft. Lawrence J. Barker. A report on tests that were conducted to determine the brittleness of aluminum-silicon-bronze sleeve couplings for hydraulic systems, and to find a means of eliminating brittleness. It was found that, for complete elimination of brittleness, the best procedure is to heat-treat the sleeves at a temperature of 1,050°F. for 2 hours after machining and before cadmium plating, and then to cool them in air. *Automotive and Aviation Industries,* April 1, 1946, pages 34, 35, 3 illus.

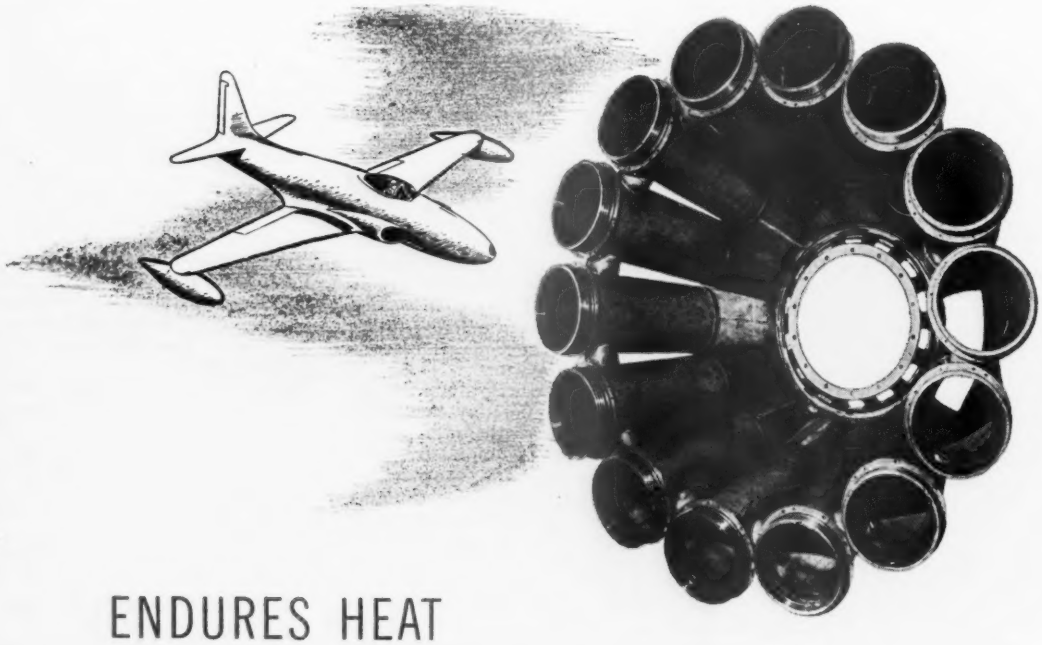
Aluminum-Bronze Permanent Mold Castings. B. Johnson. Techniques used in the manufacture of aluminum-bronze permanent-mold castings are described. The castings are produced to unusually close tolerances for antifriction-bearing separators and other purposes. It is stated that they have smoother surfaces, higher hardness, and better grain structure than comparable sand castings. Some typical examples of these castings are illustrated. Details are supplied about the mold construction and operation. *The Iron Age,* April 4, 1946, pages 80–83, 7 illus.

Precision Casting Methods and Equipment. Joseph Geschelin. The article is concerned with precision castings made by the "lost-wax" process at the Kokomo plant of the Haynes-Stellite Company, which include turbosupercharger buckets, parts for aircraft carburetors, etc. It is stated that the largest part made recently was a 1 $^1/_2$-lb. propeller hub for the Ercoupe. The advantages and limitations of the "lost wax" or precision casting process are outlined. Particulars are supplied about the plant setup. Production operations in the manufacture of precision castings are described and illustrated. *Automotive and Aviation Industries,* April 15, 1946, pages 20–23, 108, 9 illus.

The Planning Sheet. D. Tiranti. An examination of the use of a planning sheet and the information it presents is accompanied by nine illustrations of the printed forms used. The primary object is to describe the manufacturing process in the form of a predetermined sequence of operations. Detailed analysis of the planning sheet is recommended, with regard to its use, the information it gives, and how the figures are compiled. *Aircraft Production,* April, 1946, pages 195–200, 9 illus.

The Efficient Control of Twist Drills. H. Moore. Some difficult problems in drilling encountered by the fitter are discussed. Sections are devoted to methods of drilling holes in thick metal and thin sheet; techniques for drilling at an angle; and means of avoiding drill breakage. *Aircraft Engineering,* March, 1946, pages 103, 104, 6 illus.

The Manufacture and Welding of Sheet Metal Work for Jet Propulsion Engines. H. E. Lardge. Manufacturing methods developed by the British firm of Joseph Lucas, Ltd., for



ENDURES HEAT

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BEAUTIFUL ENDURING STRONG TOUGH

the production of sheet-metal equipment for jet engines are described. It is observed that the firm has been concerned with the development and manufacture of certain aspects of Whittle-type jet propulsion engines, in collaboration with Rolls-Royce, Ltd., and other jet engine manufacturers over a period of 4 years, and the Wood Tops factory was equipped for the development and manufacture of the sheet-metal parts of these engines. It is explained that sheet metal is used for the construction of the combustion and exhaust systems which, as integral parts of the engine, have to be made to a high standard of quality and dimensional accuracy. The materials used include a high nickel-chromium heat-resisting alloy, and an austenitic stainless-steel sheet. Methods of fabrication and assembly are described. Other sections give particulars about the furnaces for brazing and clean-annealing; assembly and inspection methods; and laboratory control. *Sheet Metal Industries*, April, 1946, pages 762–766, 7 illus.

Motion Economy. Part I. F. C. Bailey. The writer has made a study of "motion economy," and in this first of a series of articles outlines his system for eliminating wasted motion in aircraft-assembly work and speeding up production time in both large factories and small-quantity manufacture. The main principles are summarized in explanations of the minimum length of movement; least change of movement direction; symmetrical movements; simultaneous symmetrical movements; natural movements; rhythm of movement; development of habit; and choice of parts handled. A list of the "old" methods of assembly is compared with the much shorter "new" methods of assembly. In view of the fact that motion study has been used in electrical assemblies, the writer compares the problems presented in the aircraft industry with those of the electrical industry. Elimination of errors and methods of adjustment are considered. *Aircraft Production*, April, 1946, pages 188–192, 8 illus.

Propellers

Hamilton Standard Album. Accompanied by numerous photographs showing propeller-design changes, a review traces the evolution of the Hamilton Standard propeller. The history begins in 1909, when Thomas F. Hamilton established his factory in Seattle, Wash. Among the important developments in the progress of propeller design noted are the advance from wooden blades to hollow-steel, fixed-pitch propellers, in 1918; a propeller with detachable, drop-forged solid duraluminum blades, permitting change of blade pitch on the ground, in 1921; adjustable pitch in flight, in 1930; elimination of manual control, in 1935; and the quick-feathering Hydromatic propeller in 1938. Current modifications of the Hydromatic involve the incorporation of a new steel blade, automatic synchronization, reversing, and even more rapid feathering. The reversing feature will be available in all of Hamilton Standard's new propeller types. Other improvements now being made available are mentioned. *Air News*, April, 1946, pages 51–57, 33 illus.

Illustration Courtesy Hamilton Standard Propellers Division of United Aircraft Corporation

The Hamilton Standard square-tipped propeller blade for high-speed aircraft as installed on an Army bomber. The propeller shown is over 13 ft. in diameter. It is stated that the square tip contributes to superior blade performance because it is unnecessary to distort the design at the tip; because it permits the use of a thinner, less cambered airfoil at the tip, reducing compressibility effects; and because it allows greater power absorption with minimum weight increase.

Radio

Army-Navy Precipitation-Static Project. The first three of a series of six papers, which are designated as Parts I, II, and III, set forth the results of the joint Army-Navy Precipitation-Static Project. The object of the work was to investigate means of reducing the natural disturbances of radio reception aboard airplanes which may diminish or destroy the quality of communication, a subject of fundamental interest in both commercial and civilian aviation.

Part I—The Precipitation-Static Interference Problem and Methods for Its Investigation. Ross Gunn, Wayne C. Hall, and Gilbert D. Kinzer. To provide a background for the detailed technical papers that follow, Part I describes the organization, objectives, and problems of the project. A short bibliography on this subject is included. Methods of investigation are discussed. Problems connected with autogenous charging, exogenous charging, and the discharge of free electricity from aircraft are outlined.

Part II—Aircraft Instrumentation for Precipitation-Static Research. Ramond C. Waddel, Richard C. Drutowski, and William N. Blatt. The writers discuss the instrumentation on an airplane used for research on the problem of precipitation static. The instrumentation is employed to provide quantitative data on various phenomena concerned in the electric charging and discharging process that takes place on an airplane during flight. Sections deal with the electric field meter, dischargers, the artificial charger, noise meter, patches and induction probe, air-conductivity meter, accelerometer, and data recorder.

Part III—Electrification of Aircraft Flying in Precipitation Areas. Ronald G. Stimmel, Emery H. Rogers, Franklin E. Waterfall, and Ross Gunn. The writers examine the principal features and mechanisms responsible for the transfer of free electrical charge to an aircraft, as it flies through various

types of precipitation. The charging characteristics of a typical airplane flying through dry snow are given and correlated with reliable quantitative data obtained on the ground. The critical dependence of charging processes upon the ambient temperature and the character of the airplane's surface is noted, and the possibility of neutralizing this charging by special surfaces is demonstrated. The discharge characteristics of the aircraft are evaluated in terms of the charge carried away by the engine-exhaust ions and by corona discharge. It is concluded that under severe precipitation conditions most of the accumulated charge is carried off by corona processes. The differences between unipolar or autogenous electrification and bipolar or exogenous charging are emphasized. It is stated that both types produce serious radio interference and require different treatments for their mitigation. *Proceedings of the I.R.E. and Waves and Electrons*, April, 1946, pages 156P–177P, 24 illus.

What's Behind Airborne Radar? Part II. Donald M. Skidmore and Charles R. Chambers. The second part of an article on radar equipment for aircraft deals with the control and construction of scanners, emphasizing tilt as well as azimuth sweep. Both search and interception radar paraboloas are discussed, and the evolution and problem of refining the design are traced. It is stated that the next logical step is to combine both the search and intercept gear into one compact unit. *Machine Design*, April, 1946, pages 149–154, 4 illus.

Radio Is a Must. Doris and Ed Yulke. The importance of radio for communication and navigational aid is emphasized. It is predicted that the light-plane owner's utilization of radio equipment will be more general, and his needs are already being met by the manufacturers. A number of personal-plane radio sets are described and a table summarizes the performance, frequency range, weight, and price with regard to 20 different models. The writer calls attention to C.A.A. plans for the gradual adoption of V.H.F. equipment, noting that the manufacturers are making provision for the changeover. However, it is believed that for the next several years simplicity and reliability will be more important than wide range. Correct radio procedure is outlined, including both take-off and landing instructions. *Skyways*, May, 1946, pages 46–51, 82, 84, 16 illus.

Consol. John E. Clegg. The Consol Beacon radio aid to long-range navigation, originally developed and called "Sonne" by the Germans, is described in detail. The three component parts in the system are a radio transmitter or beacon on the ground, a radio receiver in the aircraft, and maps or conversion tables, also in the aircraft. The system involves the use of a rotating beam identified by dots and dashes. Transmission is made from the ground. The system is reported to compare favorably with other direction-finding equipment and has three important advantages: (1) more convenient and economical to generate on the ground; (2) can serve an unlimited number of aircraft simultaneously; (3) only a one-way circuit is required as opposed to the two-way circuit required for ground direction-finding stations. The frequency is between 265 and 420 kc. and enables a daytime range of 1,000 miles over sea and 600 miles over land. Night range is approximately 1,500 miles. The Consol Beacon resembles American radio-range stations in principle except that the Consol has 24 sectors while the range station has only four. Daytime accuracy is said to be within $\frac{1}{4}°$ to $\frac{1}{2}°$; at night the error is as much as 5°. *The Log*, March, 1946, pages 38–44, 2 illus.

Reaction Propulsion

Basic Principles of the Jet Exhaust Stack. E. A. Boniface. The first of a series of engineering reports refers to the basic principles and theory of reaction propulsion, and how the jet, in its various applications, produces its thrust power. The basic formulas for determining performance characteristics of the jet exhaust, as applied specifically to the exhaust system of the reciprocating-type aircraft engines, are supplied in the first installment. One purpose of the article is to clear up popular misconceptions concerning jet propulsion. *Air Transport*, April, 1946, pages 45–48, 4 illus.

Rockets for Research. Lyn David. Details of the design, construction, and operation of a supersonic, extreme-altitude research rocket are presented in this article. The designer feels that a careful study of features should include examining the general shape or profile, motive power, internal structure, special disposition of fuel tanks, control apparatus, instrumentation, and scientific equipment. Vertical rocket flight is desired because of limited amount of fuel, necessity for retrieving the rocket with its equipment and information, and for obtaining maximum altitude. The rocket under consideration will be 18 ft. long and 2 ft. in diameter. Fully loaded, the total weight will be 2,500 lbs. The present design includes radio-controlled vertical ascent, with side jets controlling any tendency to drift with wind; two fixed fins and two retractable wings, acting as stabilizing fins on the way up, and as glider flight wings on the descent, causing a controlled spiral glide to earth by means of radio beams. Landing can be accomplished on skids or trucks. A schematic diagram of the research rocket is supplied, along with a diagram of its predecessor the German V-2. *Air News*, April, 1946, pages 28–30, 4 illus.

Technical Aspects of Rocket and Jet-Assisted Takeoff. M. J. Zucrow. The fundamental principle of jet propulsion is explained with the aid of formulas, diagrams, and graphs. The essential difference between the application of Newton's Third Law of Motion by means of the propeller and the jet is noted, although both systems are based on that fundamental law. Equations are derived for computing the thrust of a thermal jet engine and for comparing it with the thrust of a propeller. The writer then explains the action of the rocket method of assisting the take-off of an airplane, how the rocket engine operates, and compares the propulsion efficiency of the rocket with that of the engine-driven propeller. Other computations are made for the effects of flight speed and altitude. The liquid-propellant and the solid-propellant types of rocket are compared, and the advantages of jet-assisted take-off are summarized. *Aero Digest*, April, 1946, pages 88, 91, 92, 95, 96, 101, 106, 109, 110, 20 illus.

Evolution of Energy in Jet and Rocket Propulsion. P. Bielkowicz. It is noted that the task of any recoil engine consists in transforming the chemical energy of fuel into the kinetic energy of gases leaving the nozzle. A brief survey is given of problems connected with transformations that the energy undergoes on the way from the fuel containers to the end of the nozzle. The problem is simplified as far as possible, examining only the conditions in a rocket engine, without a gas turbine. It is explained that even in these simplified schemes the phenomena inside the combustion chamber and the nozzle are rather complicated and require careful examination, but that successful research can give hints as to how to obtain higher power. The writer does not attempt to give full answers to the problems which have arisen but endeavors to explain the physical nature of some selected problems. *Aircraft Engineering*, March, 1946, pages 90–92.

Research

Research and Development in Aeronautics. H. E. Wimperis. In a paper presented at a meeting of the Institution of Mechanical Engineers in London, the writer surveys the development of aviation and discusses the research work that has advanced aeronautics to its present standing. The great change in the external appearance of aircraft during the past 20 years is referred to, and also the high speeds, high altitudes, and long ranges that have been attained. In considering whether or not the physical limit of future aircraft is being approached, the writer examines factors influencing flying range, flying speed, and the size of aircraft. Developments in radar are considered. Other sections deal with national aeronautical research organizations,

postwar developments, research in industry, and the engineer in human society. *Journal and Proceedings of the Institution of Mechanical Engineers*, March, 1946, pages 353-361, 8 illus.

Some Devices for the Solution of Large Sets of Simultaneous Linear Equations. W. J. Duncan. A method is proposed for the solution of large sets of simultaneous equations, which, in theory at least, is completely accurate. It is explained that the method is not new in principle, but by help of the matrix notation it is expressed in the most general and concise form. The unknowns and equations are divided into subsets, which is equivalent to the partitioning of the matrices of the coefficients and constants. Operations with the submatrices yield the complete solution of the problem. The process is of particular value when facilities exist for the solution of a certain limited number of simultaneous linear equations and it is required to solve a more numerous set. The method is called the Method of Partial Solution or the Method of Sub-Matrices. The paper was circulated among members of the Aeronautical Research Committee of the British Ministry of Aircraft Production. Sections are devoted to details of the process; the calculation of reciprocal matrices; and some alternative forms of reciprocal matrix. An appendix contains notes on the reciprocation of partitioned matrices. A list of references is included. *Philosophical Magazine*, October, 1944, pages 660–670.

Air Age Wonderland. Lucien Zacharoff. Future aeronautical engineering achievements are predicted and an account is given of the work being conducted at the Langley Memorial Aeronautical Laboratory. The development work conducted there by the N.A.C.A. is classified under ten headings: general aerodynamic research; airplane-performance improvements; airplane stability and control; aerodynamics of aircraft-engine installation; airplane-propeller research; aircraft loading research; aircraft structural research; hydrodynamic research; missiles research; and special projects. Each class of work is described briefly, in nontechnical language. *Skyways*, May, 1946, pages 30–33, 66, 12 illus.

Rotating Wing Aircraft

Ground Vibrations of Helicopters. M. L. Deutsch. The problem of "ground resonance" in helicopters is discussed, with emphasis on practical considerations. The theory is briefly reviewed and the results are stated. Formulas are given which enable calculations to be carried out for the center of the range of instability, the critical speeds for flywheel-type resonance, and the damping required to eliminate the range of instability. Landing gear and blade dampers are investigated and, finally, methods of test are considered. *Journal of the Aeronautical Sciences*, May, 1946, pages 223–228, 234, 2 illus.

The RAF's Helicopters. Flight Lt. Richard Bradbury. The development of rotating wing aircraft in Great Britain over the past 20 years is reviewed. It is stated that this extensive experimental and research program has played an important part in the perfection of present-day designs. It is noted that England made little progress with rotating wing aircraft during the war because the aircraft factories had their time occupied with more essential production. When the Sikorsky XR4 helicopter was produced in America in 1943 it was obvious that it was capable of performing many wartime duties and the Royal Navy sought to have some of the craft produced for use as an antisubmarine weapon. Owing to many setbacks, however, the program was delayed, and the Atlantic warfare subsided before sufficient aircraft or pilots were ready. *American Helicopter*, April, 1946, pages 30–32, 43, 3 illus.

Helicopters? They Had Them in Babylon! David William Moore, Jr. The similarity between the flight of the boomerang and that of the helicopter is noted. The writer explains how he first discovered this similarity through experiments with boomerang throwing. He states that mechanical helicopters, in the form of the boomerang, have been in existence for a great many years. A review of the history of the boomerang reveals that cuneiform signs indicated a knowledge of the boomerang in Babylon before 3,000 B.C. *American Helicopter*, April, 1946, pages 29, 47.

The French SE-700 Helicopter. L. de Gouvion St. Cyr. Details are supplied about a prototype helicopter recently announced by the French Air Ministry, which has been designated as the SE-700. It is 20 ft. 6 in. in length, and 22 ft. 4 in. high. The rotor, which is 41 ft. 28 in. in diameter, is of the cantilever type with three identical blades of symmetrical airfoil section. The operation of the rotor blades, which are attached to the hub by flexible links, is described. The fuselage is of wood construction and landing gear is of the steerable tricycle type. The SE-700 is powered by a 330 C.V. engine of the Bearn 6D type. Mounted in the fuselage, aft the rotor mast, it is cooled by an exhaust system installed directly behind it. The entire craft, including its total useful load, weighs two tons. *American Helicopter*, April, 1946, pages 28, 45, 2 illus.

The de Chappedelaine Helicopter. D. Margaret Leunam. The article describes a new flow-controlled helicopter that is being tested by Jean de Chappedelaine, the inventor. It is stated that this aircraft is being sponsored by the American Die and Tool Company and was built in the company's plant. A flow-controlled rotor will be installed, in which the boundary layer section will be employed to improve the lifting power of the rotor and automatically equalize the lift when the helicopter is in forward flight. Automatic balance of the machine will be secured through a floating rotor mounting. A simple pitch-control device provided with a cyclical direct control stick, which can be locked in any desired position, will permit the de Chappedelaine helicopter to fly with the hands of the pilot off the controls. *American Helicopter*, April, 1946, page 17, 2 illus.

Beneath the Whirling Wing. Wolfgang Langewiesche. A fixed-wing aircraft pilot relates his experiences with a helicopter in flight and describes the flight and control characteristics of the craft. He refers to the "shaking" in the Sikorsky R-5 as being mild, but examines current methods for minimizing this vibration. The main flight instrument, the rotor and engine tachometer, is illustrated, and operational procedure is explained. The writer also gives his impressions of the Bell NC1H, a dual-controlled, civilian, lightweight helicopter that has a side-by-side seating arrangement and a two-blade, wooden rotor, rotating at 300 r.p.m. Flyweights are used directly under the rotor as a stabilizer. *Air Facts*, May, 1946, pages 31–56, 4 illus.

Convertible Aircraft. David Prince. The Vice-President in charge of the Engineering and Consulting Laboratory of the General Electric Company gives his views regarding the future of the helicopter. He expresses the opinion that the helicopter will change accepted ideas of military, commercial, and private aircraft, including methods of basing and operating them. *American Helicopter*, April, 1946, page 41, 1 illus.

The LZ-1 versus Rotary Confusion. Glidden S. Doman. A general discussion of the underlying factors in the analysis of vibration in rotating wing aircraft is presented. The new LZ-1 helicopter of Doman-Fraiser Helicopters, Inc., which is designed for special demonstration and research activities, is described. It is stated that in the design of this aircraft special attention has been given to problems of main-rotor fatigue failure and the objectionable vibration generally found in both the structure and control mechanism. With the object of obtaining confirmatory strain data on the design at the earliest possible moment, the LZ-1 has been provided with a six-cylinder

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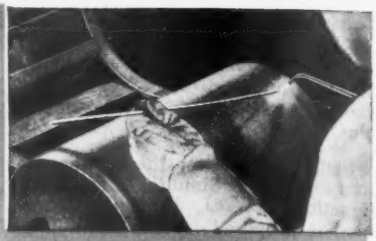

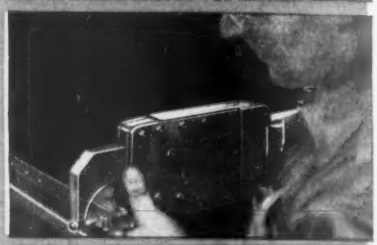

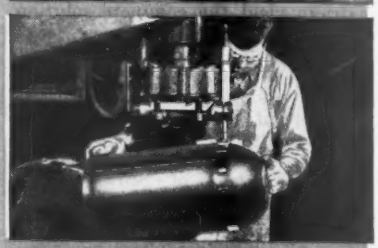

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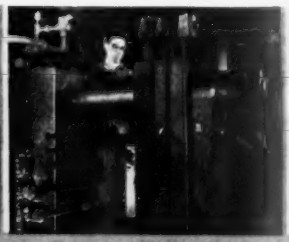
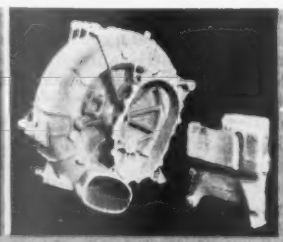
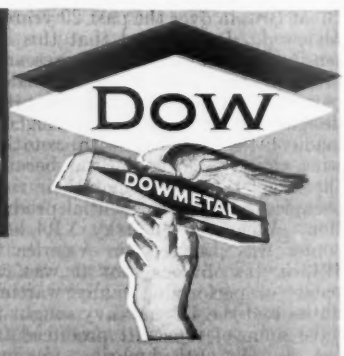


Die casting is one of the numerous magnesium production methods. Dow engineers cooperate with many independent die casters.



Many magnesium sand castings, too, are serving to reduce weight in new products in both consumer and industrial classifications.



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Franklin engine of 180 hp. to enable flights with heavy test equipment. Variable loads are directly under the rotor, with the result that the center of gravity is not affected by changes in load. This provides added assurance of long blade life and places the engine out in front for easy servicing. Autorotative landings are made possible through a low disc loading and an extremely soft landing gear. *American Helicopters*, April, 1946, pages 34, 35, 1 illus.

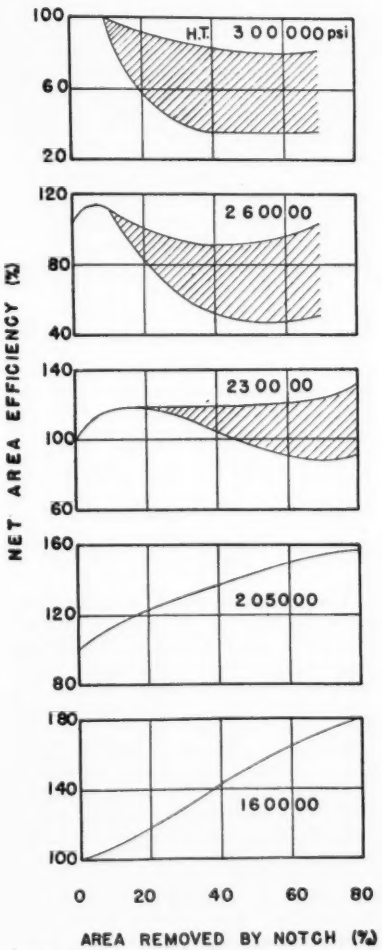
Helicopter Landing Technique. The basic differences between the autogiro and the helicopter are pointed out in an article explaining "dead" engine landing procedure in a helicopter. Landing a helicopter with the engine stopped is stated to be more difficult than in an autogiro; the rotor is more heavily loaded and the sinking rate is higher. Increase in rate of descent, causing acceleration of the rotor, builds up a high degree of kinetic energy in the blades, providing power immediately before landing. The methods for landing without the use of the engine in a helicopter are divided into three groups: (1) with vertical approach; (2) glide approach and landing with forward speed; and (3) glide approach and landing with zero air speed. The writer believes that a forced landing in a helicopter is safer than in a fixed-wing aircraft. *Flight*, March 28, 1946, pages 307, 308, 1 illus.

Stress Analysis

The Effect of Notches on Static and Fatigue Strength. D. W. Drake. The principal variables that determine the effect of a notch on the static and fatigue strength of a structure are discussed, their interaction is examined, and test data are presented. An explanation is offered for the apparent paradox of a material's exhibiting relatively high static notch efficiency but developing relatively low-notched fatigue strength. *Journal of the Aeronautical Sciences*, May, 1946, pages 259–269, 25 illus.

Stress Without Strain. Part II. Anthony A. Fletcher. Part II of a series of articles about propeller-blade stressing explains a set of charts worked out for different values of "Stress Ratio" ranging from 0.10 to 0.20. The writer feels that this range is adequate to fulfill requirements so far as nonmetallic propeller materials are concerned. The use of the charts in computing allowable stress at different points in the propeller-blade section is explained. Other charts supply information concerning "Activity Factors," which is said to be a better measure than "Aspect Ratio," to which it corresponds. Activity Factor is defined as a nondimensional function of the plan form, designed to express the integrated capacity of the blade elements for absorbing power. Possible criticisms of the method are anticipated and met. The characteristic curves for a hypothetic propeller are laid out on another chart. *Flight*, March 14, 1946, pages 272–274, 10 illus.

Aircraft Vibration and Its Investigation. R. N. Hadwin. Methods of vibration stress measurements are reported in an article by the Chief Vibration Engineer of The de Havilland Aircraft Company, Ltd. The effects of vibration are summarized as (1) oscillating motion discernible by human beings; (2) premature mechanical failures attributable to fatigue; (3) large excess-weight penalty imposed on the structure in order that it may carry vibratory loads as well as steady loads. Other points outlined and studied include methods of measuring vibration, strain-gaging of rotating structures, problems associated with turbines, testing to destruction, and the use of lighter propellers. A graph illustrates the gradual decrease in propeller weight per horsepower over the past years, made possible by the designers' more exact knowledge of the working stresses in the propeller. A diagram shows the layout of an electrical system for testing propeller stresses. Other diagrams reproduce the records made by the instruments of vibrations of propeller blades. *The Aeroplane*, April 12, 1946, pages 426–429, 9 illus.



Variation of net area efficiency with depth of notch for different material strengths. Specimens are "V"-notched bars of SAE 3140 steel in tension.

Structural Testing

Structural Testing of Civil Aircraft. A report is given about structural testing being carried on in the Structural and Mechanical Engineering Department at the Royal Aircraft Establishment at Farnborough, England, of a half-scale model of the Bristol 167 (Brabazon I) civil air liner. The writer states that the largest frame for holding aircraft now in existence, the "Cathedral," accommodates aircraft up to the size of the Avro Lincoln only. The much larger Bristol 167 has been reduced to half scale for the test. It is pointed out that the test results, instead of being a check on actual strength values, will be a check on the accuracy and the methods of the stress calculations employed. Structural tests are being conducted on wing stiffness, both torsional and flexural, and on landing-gear attachments. Detail tests will follow on propeller mountings and simulated engine loadings; a proof strength test on the whole wing assembly and on the aileron torsion case; and, finally, proof and destruction tests will be made under the gust case when the assembly will be loaded until it breaks. *The Aeroplane*, April 5, 1946, pages 403–405, 5 illus.

Superchargers

Application of Turbosuperchargers to Postwar Commercial Aircraft. F. W. Disch. Highlights of the Boeing Aircraft Company's past experience with turbosupercharged airplanes are reviewed. Problems of installation are considered and suggestions are offered for future design. Choosing a basic airplane and engine, the writer analyzes several types of supercharger. A method of selection of the turbosupercharger also is briefly presented. Assuming that flight at 25,000 ft. is desired, a comparison of range and pay load is shown, depicting the benefits of employing a cruising type of turbosupercharger for increased fuel economy and range. The article concludes with a summary of the overall benefits of this type of installation. *SAE Journal*, April, 1946, pages 158–168 (Transactions), 26 illus.

A Study of Surging in Fan or Compressor Systems. R. C. Binder. It is noted that in centrifugal compressors and superchargers a periodic fluctuation may be superposed upon the main steady flow, and that this surging may become dangerous and limit the useful range of operation of the machine. An analytic study is presented which explains the cause of one type of surging in a system connected to a fan compressor. Methods

are outlined for the elimination of surging. *The Journal of The Franklin Institute*, February, 1946, pages 125–136, 5 illus.

Testing Equipment

Electric Strain Gages Aid Machine Design. V. E. Hillman. It is observed that wire strain gages, commonly known as SR-4 gages, have been used extensively during the past few years, particularly in the aircraft industry, and that designers of all kinds of mechanical devices are turning to them for intelligent direction in problems that involve stress. The principle of operation and the method of using these gages are described. Information is supplied about the indicating equipment necessary for observing the results. *The Iron Age*, April 11, 1946, pages 50–53, 6 illus.

Regenerative Dynamometers. W. R. McAlpine. After 2 years of operating experience with three regenerative-dynamometer test beds, the conclusions are reported in a simple but detailed explanation with accompanying diagrams. The operation and function of this English electrical equipment at the works of D. Napier and Sons Ltd. is described. Designed to enable power to be fed back to the public-utility mains, the methods are reported to have given results better than had been anticipated. The topical headings of the information are functions of exciters; functions of four main controllers; automatic constant-speed device; dynamic braking; and running experience. *Aircraft Production*, April, 1946, pages 181–187, 13 illus.

Tools and Equipment

Conveyor Speeds Sheet Metal Parts Production. A conveyer system for the layout, drilling, and routing operations on sheet-metal parts is described. Installed in the Inglewood plant of North American Aviation, Inc., it is believed to be the first of its kind. The new system is compared with the one formerly used, and the advantages through its installation are outlined. Under the new system, a 22-station intermittently operated conveyer times the various operations at 15-min. intervals by moving 14½ ft. at a speed of 30 ft. per min. *The Iron Age*, April 25, 1946, page 55, 1 illus.; "North American Installs Sheet Metal Conveyor System," *Automotive and Aviation Industries*, April 15, 1946, pages 34, 35, 108, 7 illus.

Case-Hardening Gears. L. Sanderson. The procedures used and the advantages of the salt-bath type of furnace for carburizing and tempering gears are analyzed. Degrees of distortion, the advantages of liquid carburizing, bath capacity, and heating time are examined. *Aircraft Production*, April, 1946, pages 193, 194.

Illustration Courtesy Boeing Aircraft Company

Rear view of parallel turbo installation as tested on a Boeing B-17 airplane to demonstrate the feasibility of dual operation and the possibility of changing from dual to single turbo operation for increasing benefits.

Training

Night by Day. The "Day-Night" instructional system of night landing and instrument-flying training, developed during the first 2 years of the war in England, is now part of the normal training curriculum of the R.A.F. Four "day-night" flying schemes are in use: (1) the Single-Stage "Flarepath" Scheme, for which the pupil wears special goggles and is able to see only the sodium-lamp flarepath and his sodium-lighted instruments; (2) the Two-Stage "Flarepath" or Two-Stage Brown Scheme, in which all but the light from the flarepath and instruments are cut off in two stages for the pupil; (3) the Two-Stage Blue Scheme, in which the aircraft is fitted with pale blue screens and the pupil wears amber goggles; and (4) the Two-Stage Amber Scheme, in which the color positions are reversed. The use of filters incorporated in this training plan is described in theory and in practice. The advantages and practical limitations of the system are discussed. *Flight*, March 28, 1946, pages 312, 313, 4 illus.

The Private Pilot Flight Test. Alva N. White. In an informative discussion enumerating and explaining the requirements for passing the flight test for a Private Pilot Certificate, the writer reviews correct procedure for basic maneuvers. Those included are: preflight procedure; technique before becoming air-borne; climbing turns; 720° turns (steep); stalls and slow flight; spins; glides and gliding turns; pylon eights; accuracy landings; and emergencies. *Air Facts*, May, 1946, pages 57–70.

Can You Qualify? Norman J. Bogomolia. The article outlines the qualifications required to fly a helicopter. Eleven steps are listed which, according to a former test pilot for the Sikorsky Aircraft Division of United Aircraft Corporation, must be taken in a final check to ascertain whether a helicopter pilot has met all requirements. *American Helicopter*, April, 1946, pages 33, 45, 1 illus.

Billion-Dollar Boost for Civil Aviation. James E. Batchelor and Richard H. Landrum. The important aspects of flight training for veterans are examined. It is estimated that 160,000 training planes will be required for this Government-financed training program, representing four times the number of trainers now in existence. Methods of establishing a flying school are enumerated, with regard to different state rulings. The C.A.A.'s new guide book, outlining a flight-training program, is recommended for additional information. The importance to veteran employment is found in view of the predicted need for 50,000 flight instructors, 30,000 ground-service personnel, and 30,000 aircraft and engine mechanics. It is stated that the manufacture of 50,000 to 75,000 airplanes per year will aid in solving the unemployment problem in the aircraft-manufacturing industry. *Southern Flight*, April, 1946, pages 31, 38, 42.

AAF School for Helicopter Mechanics. Lt. Porter L. Hough. The article gives information about the course for training helicopter mechanics, which was started by the A.A.F. in the Spring of 1942 at the Technical School, Chanute Field, Ill., and later transferred to Sheppard Field, Tex. How the course was expanded and improved is described. Details of the present 8-week course are enumerated. *American Helicopter*, April, 1946, pages 18, 19, 44, 7 illus.

Welding

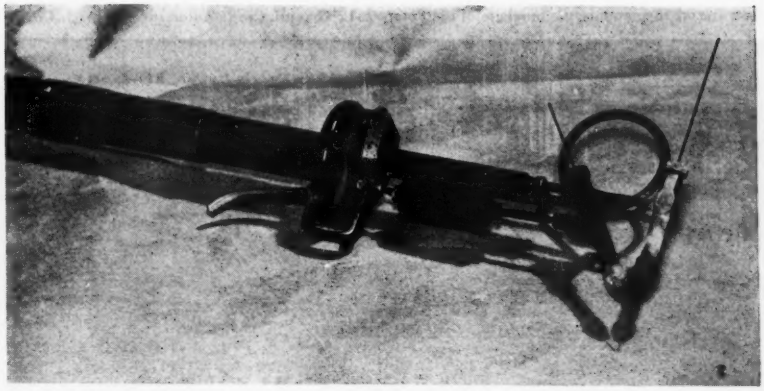
Atomic Hydrogen Welding in Aviation. Frederick S. Dever. The application of atomic hydrogen welding to the fabrication of aircraft parts is reviewed, with particular attention to

methods used by the Ryan Aeronautical Company in the welding of engine exhaust systems constructed of light-gage stainless-steel sheet. Advantages of atomic hydrogen welding are outlined. How certain difficulties with the method were overcome through careful evaluation of lessons learned is described. The use of this method for welding low-carbon steel sheet also is discussed. Welding operations and parts welded by the atomic hydrogen process are illustrated. *The Welding Journal*, April, 1946, pages 309–312, 9 illus.

Electronic Control. B. G. Higgins. A second article concerning electronic control and resistance welding follows the article in the March issue of *Aircraft Production* (AERONAUTICAL ENGINEERING REVIEW, May, 1946). This second article describes the basic principle behind resistance welding. The development, the problems involved, and the gradual improvements in the field are outlined for the past 40 years. It is stated that the advent of the electron tube, or valve, solved the problem of the constant welding time and also shortened this time, increasing production speeds.

Reference is made to electronic tubes controlling the current through a magnetic contactor and those directly controlled electronically. The second of these, dealt with extensively, is subdivided into spot-welder controls and seam-welder controls. For spot welding of aluminum alloys used in the manufacture of aircraft parts, it has been found that higher quality and stronger welds result if the welding current is followed immediately by a postweld heating current. Pulsation welding, used for heavy sections or for welding thick and thin sections together, is discussed and diagrammed. The difficulties in seam welding are outlined and the manner in which these problems are being solved by electronic welding is explained and illustrated. *Aircraft Production*, April, 1946, pages 155–159, 12 illus.

Electric Resistance Brazing of Structural Aluminum Alloys. W. F. Hess and E. F. Nippes. The results of an investigation undertaken to study the possibilities of electric resistance bonding of high-strength aluminum alloys are presented in a report to the Office of Production Research and Development, War Production Board. One object of the study was to determine whether an electric resistance brazing operation might be superior to seam welding from the standpoint of power requirements and metallurgical damage to the structural aluminum alloy. A second purpose of the investigation was to determine whether the sealing of a lap joint in structural aluminum alloys by means of low-melting-temperature metals might be superior to the use of plastic compounds or resin bonding from the standpoint of durability or ease of application. Aircraft fabricators indicated an interest in this type of joint in order to obtain higher joint efficiency than is possible with spot welding, and at the same time to accomplish air or liquid sealing required by pressurizing of cabins and storage of fuel or lubricating oils. The materials and equipment used in the experiments are described. Information is supplied about the procedures for applying bonding materials and for electric resistance brazing. The results obtained with electrobrazed, spot-welded, and seam-welded specimens are enumerated. *The Welding Journal*, April, 1946, pages 193-s–200-s, 14 illus.



Photograph Courtesy Ryan Aeronautical Company

An atomic hydrogen welding torch, showing the twin tungsten electrodes incased in hollow sleeves through which the hydrogen flows.

Filler Metal Flow in Brazed Steel Joints. The paper reports the results of an investigation that was carried out for the primary purpose of determining the distance silver alloy filler metal will flow in steel brazing operations in relation to the joint spacing, type of parent metal, and direction of flow. The parent metals used in the tests were SAE 1020, NE 8630, and stainless type 320 steels. A table gives the joint fill on these parent metals at representative spacings. Graphs show the way silver alloy flow in test assemblies is affected by gravity. The investigation was made at the production and development laboratory of North American Aviation, Inc. *The Iron Age*, April 11, 1946, pages 60, 61, 2 illus.

Atomic Hydrogen Welding. An article on atomic hydrogen welding describes in detail the methods used and the savings effected both in labor and material costs. The welding process for the repair of broken tools, as well as in the manufacture of tooling equipment, is explained. *Aircraft Production*, April, 1946, pages 170, 171, 6 illus.

Some Observations of Spot-Weld Consistency in Aluminum Alloys. W. F. Hess, R. A. Wyant, B. L. Averbach, and F. J. Winsor. A report prepared by the Rensselaer Polytechnic Institute describes observations of spot-weld consistency which were made in the course of an aircraft spot-weld research program. It is explained that the expression "spot-weld consistency" as used in the article applies to the shear strength of the aluminum-alloy welds. Methods of evaluating weld consistency, the first requirements for good consistency, and early observations of spot-weld consistency are discussed. Consideration then is given to the effects of current magnitude, surface conditions, current wave form, and electrode condition on weld consistency. Experiments to determine the basic course of inconsistencies in weld strength are described. *The Welding Journal*, April, 1946, pages 201-s–222-s, 27 illus.

The Welding of Non-Ferrous Metals. Part VII. E. G. West. Aluminum-alloy spot welds are the subject of a further continuation of Part VII of an article on the welding of nonferrous metals. Information is supplied about the control and inspection of spot welds. The standard control test is described. The properties of aluminum spot welds then are considered in three sections dealing with weldability, mechanical strength, and metallurgical characteristics. *Sheet Metal Industries*, April, 1946, pages 755–761, 11 illus.

Miscellaneous

18th Annual Directory of American Aircraft and Engines. Substantially the entire April, 1946, issue of *Western Flying* is given to the magazine's 18th Annual Directory of American Aircraft and Engines. Sections refer to civil aircraft; military aircraft; American aircraft engines; and a list of the names, addresses, and executive personnel of American aircraft and engine manufacturers. The aircraft descriptions are treated in a uniform style, specifying type, dimensions, areas of wings and control surfaces, weights, power plant, construction, and standard equipment. The engine specifications are set forth in a similar uniform manner, stating the engine type, performance, dimensions, construction, equipment, lubrication method, and weight. *Western Flying*, April, 1946.

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Government Publications

Army Air Forces

Dissemination of Foreign Air Technical Documents. Some 250 tons of German aeronautical documents that had been collected through the combined efforts of the Army Air Forces, U.S. Navy, and British Intelligence are now being prepared at Wright Field for dissemination to the aeronautical industry, research agencies, and educational institutions. This store of documentary material, consisting of about 500,000 items, has recently been moved from London to Wright Field, and the work of the Air Documents Research Center, A-2, United States Air Forces in Europe, has been taken over by the Air Documents Division of Intelligence T-2, Air Matériel Command. So far, approximately 4,000 documents have been processed for dissemination, and it is expected that, by the end of this year, about 55,000 documents considered to be of the most immediate value will have been cataloged. A card index containing approximately 20,000 cards cataloging the documents already processed is now available for distribution.

Copies of the card index will be furnished free of charge to those agencies that will certify to an agreement to establish and maintain a complete catalog file. A list of locations of files available for reference to those agencies that are unable to maintain such a file will be supplied upon request. Microfilm copies of the processed German documents can be obtained by interested parties. The number of English translations of German documents is increasing gradually, as each agency is requested to provide copies of its translations. The Air Documents Division is publishing bulletins informing participating agencies of all documents that have been translated or are in the process of translation so that duplication will be kept to a minimum. Entry will also be made on index cards as soon as the document has been translated.

In addition to the index cards, the Air Documents Division is preparing bibliographies on selected subjects and compiling a German-English dictionary, containing the latest aeronautical terms. To date, approximately 32,000 terms have been edited, and there will be about 45,000 terms in the published edition of the dictionary.

Close cooperation is maintained with the U.S. Navy and other Government agencies in this endeavor. In the near future, all declassified documents will be sent to the Publication Board of the Department of Commerce and will then be available from that office in printed form.

All communications concerning this material should be addressed to the Commanding General, Air Matériel Command, Wright Field, Dayton, Ohio, Attention: Air Documents Division, T.S.R.E.D.

The Future of the Air Forces. The essentials of the proposals advanced by Lt. Gen. Carl A. Spaatz shortly after he assumed the duties of the Commanding General of the Army Air Forces are reviewed. His program deals with the transition of the organization to a peacetime basis, its mission and status as a part of the armed forces of the nation, its permanent strength, and the functions of the Air Reserve and the Air National Guard. Other parts of the program treat of the deployment of the available units, the command organizations, and provision for the necessary personnel. *Air Force,* March-April, 1946.

Operation Crossroads. Accompanied by a chart of the organization of Joint Army-Navy Task Force One for carrying out the experiments with atomic bombs in the Pacific area, an outline is given of the plans for the operation. The officers assigned to the various sections of the project are named and the duties of the units comprising the A.A.F. Task Group are briefly specified. *Air Force,* March-April, 1946.

The Atomic Present. Major Kenneth Gantz. The implications of the discovery and use of atomic power as a weapon of warfare are reviewed briefly from the standpoint of possible defense and in the matter of offensive-defensive policies to be adopted by the A.A.F. The writer proceeds to a consideration of other weapons of recent origin, such as rockets and guided missiles, noting that changes in strategy and tactics will be required constantly to keep up with technologic developments. *Air Force,* March-April, 1946.

Civil Aeronautics Administration

An Analysis of Inspectors' Ratings of Check Flights as Recorded on Form ACA 342Z. Leon Festinger, L. S. Kogan, H. S. Odbert, and Seymour Wapner. The report is one of a series resulting from extensive study known as the 1943–1944 Midwest-Navy Training Project, and is concerned with an analysis of inspector ratings of flight performance. It was undertaken at the request of the Safety Regulation Division of the C.A.A., with a view toward determining the reliability and other characteristics of the rating form ACA 342Z, designated as "Pilot Flight Test Report and Flight Inspectors' Recommendation."

The investigation undertook to examine the variation in the ratings assigned by inspectors, the agreement between flight inspectors in rating successive flights for the same students; the consistency with which specific errors were recorded; the importance of certain errors; discriminating between trainees; and the tendency of certain inspectors to show bias in respect to certain items.

The modified version of Form ACA 342Z employed in this study lists various types of errors for each maneuver to be marked during flight. The inspector was required to give a percentage grade on each maneuver independently of the marking of specific errors and, at the completion of the flight, to give an average grade on the flight as a whole.

The results are set forth in tables and charts in addition to extensive comments in the text matter, and the findings are summarized. The analysis was conducted at the University of Rochester, using data obtained in the Midwest-Navy Training Project at Ohio State University, by means of a grant-in-aid from the National Research Council Committee on Selection and Training of Aircraft Pilots, from funds provided by the C.A.A. *Division of Research Report No. 58,* March, 1946.

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This remarkable rotary wing craft offers a new kind of *all-weather* utility. The Bell Helicopter needs no airports, no costly pavements or other landing facilities. It can reach hitherto inaccessible places. And it can land safely in "auto-rotation".

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On March 8, 1946, Bell Aircraft received a CAA Airworthiness Certificate on its two-place Model 47 helicopter, and CAA license number NC 1H, *the first helicopter "NC" license ever issued.* These certificates were issued after exhaustive flight tests in which the Model 47 ... prototype of the Model 47B ... met every airworthiness requirement of the CAA.

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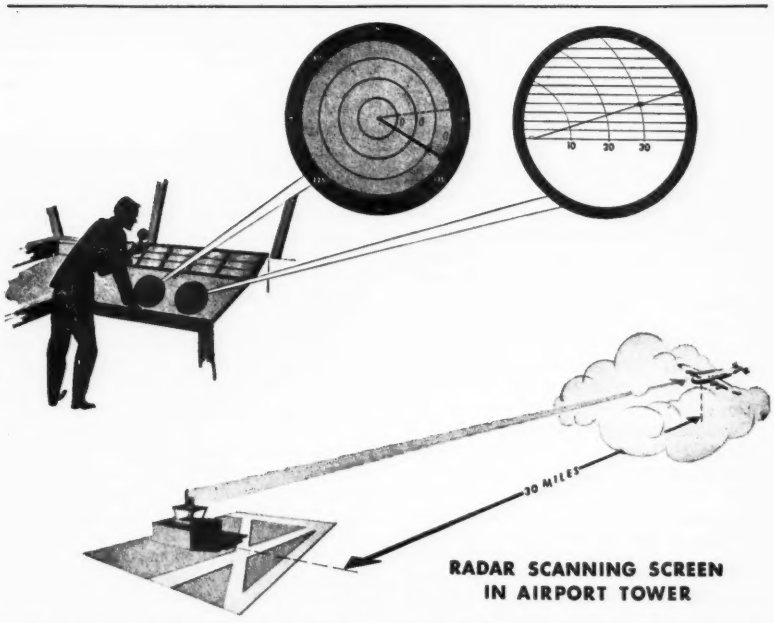
PACEMAKER OF AVIATION PROGRESS

Comparison of Student Pilot Performance in Successive Check Flights As Measured by Photographic Records. Seymour Wapner, Leon Festinger, and Henry S. Odbert. Another report forming a part of the Midwest-Navy Training Project is based on photographic records obtained from the University of Pennsylvania Project. Photographic records of a special instrument panel were obtained while student pilots, each having approximately 35 hours of training, executed two successive check flights. Records of 16 maneuvers in each flight were analyzed during slow-motion projection, and readings of specific aspects of performance were recorded on check sheets. Readings were obtained of average air speed, r.p.m., air-speed variation, average bank, altitude gain or loss, altitude variation, maximum rate of climb, and ball-bank deviations.

Results of the investigation were as follows: (1) Of the nine aspects of performance studied, only three (average Air-Speed, Average Bank, and R.P.M.) yielded correlations of any appreciable size when compared with the corresponding single measure in the second flight. These appear to represent less complex aspects of performance which may become relatively fixed early in training and are not as predominantly associated with "skill" as are other items in the analysis. (2) When corresponding measures in several maneuvers were summated for each flight, correlations tended to be somewhat higher than the median correlations on single maneuvers. In most cases the degree of consistency was so slight that many measures would have to be taken to obtain a score of adequate reliability. (3) Items related to smoothness of performance (Variation in Air-Speed, Bank, Altitude, etc.) exhibited generally low levels of consistency. (4) Comparison of the two flights in terms of mean scores on each of the items revealed little evidence of significant change in the direction of either improvement or decline in performance from first to second flights. *Division of Research Report No. 59,* March, 1946.

Studies in Motion Sickness, Series B. G. R. Wendt, A. D. Tuttle. The second report of a series describing investigations on motion sickness, administered by Wesleyan University under grants-in-aid from the National Research Council Committee on the Selection and Training of Aircraft Pilots, is divided into three parts. Part I is titled "Frequency of Susceptibility to Motion Sickness Among Young Adults," and is based on a series of questionnaire surveys among seven groups of college students and a group of air-line stewardesses. The questionnaire included items referring to sea, train, automobile, street car, and bus travel; elevators, lawn swings, and amusement-park devices. Four forms of questionnaires were used. The results are given in text form, with tabulated figures, and an appendix contains samples of the questionnaires and an inventory of cases of motion sickness.



The most immediate application of radar to commercial flying probably will be the use of a standard scanning screen by the airport control-tower traffic controller. This would enable him to "see" planes approaching to land and facilitate the job of bringing them in for safe landings under bad weather conditions. Such a screen is being installed at Indianapolis where the C.A.A. will use it as a supplement to the standard instrument-landing system while further development of radar proceeds. The diagram indicates how the screen would show the operator the distance of a plane from the tower and its direction.

Part II is titled "Airsickness Among One Hundred Eighty-nine Airline Stewardesses and Its Relationship to Previous History of Motion Sickness." The questionnaire was distributed to 189 stewardesses of United Air Lines, requiring them to report the frequency and degree to which they had been airsick and the conditions under which sickness had occurred. The procedures are outlined, and the results are tabulated and discussed in the text matter. An appendix outlines the method of scoring and contains a chart showing the airsickness ratings.

Part III is titled "Airsickness Among Seventy-one Student Pilots and Fifteen Instructors and Its Relationship to Previous History of Motion Sickness." The questionnaire was administered to 71 civilian student pilots in the Civilian Pilot Training Program of the C.A.A. and to 15 instructors in the same program, requiring them to report the frequency and degree to which they had been airsick and the conditions under which it had occurred. Results are presented in a similar manner to the foregoing sections. *Division of Research Report No. 60,* April, 1946.

Airworthiness Directives, superseding pertinent portions of Safety Regulation Release No. 182. The purpose of this Release is to amend paragraph B.2 (page 3) of Safety Regulation Release No. 182. Recent experience has indicated that a revision is necessary and the following should be substituted for the above-mentioned paragraph: (a) All notes on Airworthiness Directives that cover repetitive inspections or repetitive replacements will be Service Notes. (b) All notes on Airworthiness Directives, including Service Notes, will bear directly on safety. Operation or service information that does not have a serious bearing on safety will be omitted from Airworthiness Directives. (c) The introductory paragraphs in each Airworthiness Directive will be amended to call the owner's attention to the necessity for complying with the Service Notes at the stated intervals, and will contain a statement regarding adjustment of the stated inspection intervals to agree with Scheduled Air Carrier operator's approved inspection and overhaul periods. (d) Compliance with Service Notes will be urged on the owners but will not be checked by inspectors except as noted; (e) Service Notes will be checked by the C.A.A. inspector or representative at each annual certification. *Safety Regulation Release No. 200,* March 21, 1946.

Civil Air Regulations, Part 43, Section 43.22, concerning annual inspection of nonscheduled aircraft. The purpose of this release is to clarify the regulation to which reference is made. Section 43.22, dated July 1, 1945, is quoted as follows: "An aircraft shall not be flown except for airworthiness flight tests, unless within the preceding 12 calendar months it has been given an annual inspection

as prescribed by the Administrator and has been found airworthy by a person designated by the Administrator. A copy of the last inspection report shall be attached to the aircraft operation record and a copy filed with the Administrator."

It is the intent of the Civil Aeronautics Board that the foregoing become effective as an enforceable regulation on July 1, 1946. Accordingly, an aircraft that has not been given an annual inspection within 12 calendar months preceding July 1, 1946, will no longer be considered as airworthy, and, if flown, except for airworthiness flight tests, the owner or operator may be held in violation of Civil Air Regulations.

New aircraft and surplus military aircraft that were issued original airworthiness certificates after July 1, 1945, will be considered to have met the requirements for an annual inspection as set forth in Part 43, Section 43.22. For the purpose of complying with Section 43.22, the validity period in such cases will be twelve calendar months from the date of issuance of the airworthiness certificate. *Safety Regulation Release No. 201*, March 26, 1946.

Airport Buildings. An 86-page booklet refers to the problems of airport-building design. It is not intended to be an exhaustive treatment of building construction but an outline of the requirements for airport buildings. An attempt is made to point out how airport buildings can be designed to meet immediate and future needs. It sets forth the principles of design so that a structure may be expanded, making recommendations on such a flexible basis that future conditions may be met most satisfactorily. Diagrammatic illustrations show the relationship of the various facilities to each other. The recommendations pertain not only to airport functioning but also to the production of the greatest possible amount of revenue. The book is divided into two principal parts, the first referring to terminal airports and the second to private-flying airports. *Office of the Assistant Administrator for Airports.* For sale by the Superintendent of Documents, Washington, D.C., $0.20.

Service "A" Meteorological Information. The fourth edition of Volume III of the Federal Airways Manual of Operations constitutes Chapter B, Part 6, Section I. This unit of the manual contains operating arrangements for the distribution of meteorological information concerning the Service "A" communications system of the C.A.A. It outlines the procedure for relaying meteorological reports and the methods, times, and other factors governing the distribution of such information through C.A.A. circuits. *Communications Division, Office of Aviation Information.*

Statistical Handbook of Civil Aviation. A new edition of the *Statistical Handbook of Civil Aviation* contains statistics for the calendar year 1945 and covers additional subjects, including international and territorial air-carrier operations. It contains 129 pages, compared with 86 in the first edition.

The handbook is stated to be the first compilation in one volume of essential civil-aviation statistics. Its contents include chapters on airports, airways, domestic air-carrier operations and accidents, international and territorial operations and accidents, nonair-carrier flying operations and accidents, aircraft and airmen certifications, training programs, aircraft production and exports, and U.S. aviation "firsts." The revised edition includes an index and numerous new pictographs.

Owners of loose-leaf copies of the first edition wishing to purchase the new handbook should specify that they want the pages in loose-leaf form. Change sheets will be issued by C.A.A. during 1946 as required, and will be sent upon request to the *Office of Aviation Information.* For sale by the Superintendent of Documents, Washington, D.C., $0.25.

Consolidated Airman's Guide. The C.A.A.'s first consolidated *Airman's Guide*, a publication for certificated airmen actively engaged in flying, incorporates in a single book with an average of 162 pages what formerly comprised three books totaling 408 pages. The charts appearing in the new book include all the data concerning aeronautical facilities and obstructions, the major changes from the former charts being the addition of minimum safe altitudes and the mileage between radio fixes. Formerly, the condition of airfields and other data were carried in the Bi-Weekly Notice to Airmen in the form of symbols and text; under the new plan these are in chart form.

To be released every 2 weeks, it will serve as a comprehensive guide for private and commercial pilots through its three sections, Notices to Airmen, Directory of Airports, and Air Navigation Radio Aids, each of which formerly was published separately.

The new charts, known as "Flight Planning Charts," contain all necessary information for airmen, including radio facilities, Army and Navy fields, all designated airways, and other pertinent data. Of primary importance to pilots is the fact that the information they will get in the new book will be up to date. Previously, the Directory of Airports and Air Navigation Radio Aids were published at 2-month intervals, which did not allow the rapid change possible in the new edition. *Office of Aviation Information.*

Information for Veterans about Aircraft Licenses and Employment. Three leaflets issued by the C.A.A. are intended to answer the questions of veterans about A and E licenses.

The mimeographed "Excerpt from Part 24" tells exactly what is required for the licenses. On page 4 there is a list of the materials needed for study and the agencies from which the various items can be ordered at low cost.

The mimeographed "Veterans Administration Offers A and E License Aids" gives detailed information about the assistance that can be expected from the Veterans Administration, and how to get it. It also gives information about Aircraft and Engine Mechanics Schools, and a list of C.A.A.-approved A and E schools is included.

A reprint from an article in *National Aeronautics* magazine titled "Aviation Jobs for Veterans" outlines the requirements, pay scales, and sources of employment opportunities in the various sections of the aviation business. It also surveys the prospects for employment in the Government services and in private industry, and gives condensed information about the different types of licenses required and the preparations that must be made in order to qualify for such licenses. *Office of Aviation Information.*

Employment Outlook in Civil Aviation is a booklet of 26 pages, divided into five principal sections. The first section contains estimates of prospective employment in aviation, with brief descriptive paragraphs referring to various kinds of work in which airplanes are utilized, such as industrial flying, flight instruction, crop dusting and seeding, hunting, forestry, inspection of oil and power lines, aerial photography, and others, as well as the opportunities in the scheduled air lines, private flying at the airports, and in the Government.

Sections II and III give instructions for starting and operating a small airport. Section IV tells how to operate a flying school. Section V makes suggestions about running an aircraft and engine repair shop.

The concluding pages of the booklet contain a directory of the regional organizations of the C.A.A., with the names and addresses of the regional airport superintendents and engineers, and the regional and district offices. *Office of Aviation Information.* For sale by the Superintendent of Documents, Washington, D.C., $0.10.

Department of Labor

The Job of the Airplane Pilot (Dictionary of Occupational Titles Code No. 0-41.10). A small folder of 16 pages outlines answers to questions concerning what the airplane pilot does, how he qualifies, what he earns, and the employment outlook. These questions constitute the topical heads and the text matter supplies the answers to each of the questions. *Occupational Brief No. 69, Occupational Outlook Division of the Bureau of Labor Statistics*, October, 1945. For sale by the Superintendent of Documents, Washington, D.C., $0.05.

Joint Board on Scientific Information Policy

U.S. Rocket Ordnance Development and Use in World War II. A pamphlet of 57 pages released by the Joint Board on Scientific Information Policy for the Office of Scientific Research and Development, the War Department, and the Navy Department, summarizes the results of the use of rocket weapons in the late war. Following introductory chapters reviewing the history of rocket weapons in warfare many years ago, the fundamentals of the present construction and operation of rocket ordnance, and the organization of rocket laboratories by governmental departments at various universities, the report gives the details of the uses of rocket weapons against enemy submarines. One chapter deals with rocket armament for aircraft, tracing the history of aircraft-rocket development, the various types of these weapons and devices for launching them, and tells how they were used against the enemy in the different theaters of war.

Other sections deal with the use of rockets in amphibious warfare, the employment of the "Bazooka" against tanks, the use of rockets in ground warfare, and other specialized uses of these weapons.

National Advisory Committee for Aeronautics

Measurement of the Arithmetic Mean Velocity of a Pulsating Flow of High Velocity by the Hot-Wire Method. John R. Weske. The report deals with an experimental method of measuring both the arithmetic mean velocity and the instantaneous velocity of pulsating flow, and with the instruments developed for this purpose. A circuit for a hot-wire anemometer applicable to the measurement of fluctuating flow is described. The principal elements of the circuit are a Wheatstone bridge, one branch of which is the hot wire, and an electronic amplifier and a current regulator for the bridge current, which in combination maintain the bridge balance. Hence, the hot wire is kept at practically constant resistance and temperature, and the time lag caused by thermal inertia of the wire is thereby reduced. Through the addition of a nonlinear amplifier stage the reading of the instrument has been rendered proportional to the velocity.

A discussion of static and dynamic response of the circuit and of directional characteristics of the hot wire is given. Calculated characteristics are related to the results of calibration tests. Hot-wire measurements of mean velocity and of the velocity profile of instantaneous velocities were obtained at the outlet of a rotating axial flow blade grid and correlated with measurements obtained with a pitot tube. *Technical Note No. 990*, April, 1946.

Numerical Procedures for the Calculation of the Stresses in Monocoques. Part III: Calculation of the Bending Moments in Fuselage Frames. N. J. Hoff, Paul A. Libby, and Bertram Klein. This report deals with the calculation of the bending moments in and the distortions of fuselage rings upon which known concentrated and distributed loads are acting. In the procedure suggested, the ring is divided into a number of beams each having a constant radius of curvature. The forces and moments caused in the end sections of the beams by individual unit displacements of the end sections are listed in a table designated as the operations table in conformity with Southwell's nomenclature.

The operations table and the external loads are equivalent to a set of linear equations. For their solution the following three procedures are presented: (1) Southwell's method of systematic relaxations. This is a step-by-step approximation procedure guided by the physical interpretation of the changes in the values of the unknowns. (2) The growing-unit procedure in which the individual beams are combined successively into beams of increasing length until finally the entire ring becomes a single beam. In each step of the procedure a set of not more than three simultaneous linear equations is solved. (3) Solution of the entire set of simultaneous equations by the methods of the matrix calculus.

In order to demonstrate the manner in which the calculations may be carried out, six numerical examples are worked out. The results of these calculations are checked, whenever possible, by calculations carried out according to known methods of analysis. The agreement is found to be good.

The amount of work necessary for the solution of ring problems by the methods described in the present report is practically independent of the degree of redundancy of the structure. For this reason the methods are recommended by the writers for use particularly in problems of rings having one or more internal bracing elements. *Technical Note No. 998*, April, 1946.

Numerical Procedures for the Calculation of the Stresses in Monocoques. Part IV: Influence Coefficients of Curved Bars for Distortions in Their Own Plane. N. J. Hoff, Bertram Klein, and Paul A. Libby. In Part III of these investigations (*N.A.C.A. T.N. No. 998*, 1946) the bending moment distribution in closed rings was calculated by numerical methods. In the course of these calculations it was observed that the determination of the influence coefficients of ring segments is rather laborious. Influence coefficients are the force and moment reactions at the ends of ring segments that correspond to prescribed unit displacements. Their values must be known when ring problems are solved by the numerical methods.

Formulas for the calculation of influence coefficients of curved beams of constant radius of curvature are presented, corresponding to displacements in the plane of curvature. Numerical values are given in tabular and graphic form for a limited number of values of the parameters involved. *Technical Note No. 999*, April, 1946.

Errors in Indicated Strain for a Typical Wire Strain Gage Caused by Prestraining, Temperature Changes, and Weathering. William R. Campbell. Tests were made on a wire strain gage of representative design to determine zero shift after straining at room temperature, error in indicated strains at high and low temperature, and changes in calibration factor and zero shift after exposure to severe weathering.

The measured zero shifts after the first cycle of prestraining to 34.8 by 10^{-4} in tension or compression were less than 2.1 by 10^{-4}; after the fourth cycle they were less than 0.15 by 10^{-4}. The zero shift was always opposite to the direction of the applied strain; a cycle of tensile strain resulted in a decrease in the resistance of the wire strain gage corresponding to zero strain, and a cycle of compressive strain resulted in an increase.

The errors in indicating a strain up to 40 by 10^{-4} at temperatures between $-50°$C. and 64° C. were less than 1 by 10^{-4}. These errors could be ascribed entirely to imperfect matching of the thermal coefficients of resistance of the working gage and the compensating gage.

Calibrations and zero shift measurements on 18 gages, twelve of which were exposed to 32 days of severe winter weather, showed that the changes in calibration factor of individual gages due to the weathering did not exceed ±1 per cent even for gages with no waterproofing. Gages attached with Duco cement and waterproofed showed negligible zero shift following the period of weathering, whereas unwaterproofed gages gave zero shifts corresponding to an apparent tensile strain of 1 by 10^{-4}. *Technical Note No. 1011*, April, 1946.

A Method for the Determination of Air Infiltration Rates in Airplane Cabins. Jackson R. Stalder and E. Lewis Zeiller. A method for the experimental determination of the rate of infiltration of air into aircraft cabins during flight has been developed and tested. This method consists of releasing a quantity of gas in the cabin and calculating the infiltration rate from the measured rate of change of the gas concentration. The results of the flight tests indicate that after the infiltration rate is established at one altitude and air speed, the infiltration rates at other altitudes and air speeds can be calculated. *Technical Note No. 1017*, April, 1946.

A Fixture for Compressive Tests of Thin Sheet Metal Between Lubricated Steel Guides. James A. Miller.

A fixture for compressive tests of thin sheet metal consists of two hardened steel guides between which the specimen is held by two adjustable clamps.

Tests were made with the fixture on specimens about 1/2 in. wide by 2 1/4 in. long. The specimens were coated with a lubricant intended for use in the front-wheel bearings of automobiles. Tests were made on aluminum-alloy sheets 0.032 and 0.128 in. thick, magnesium-alloy J1-h sheet, 1025 carbon steel sheet 0.054 in. thick, and three sheets of stainless steel with thicknesses of 0.020, 0.011, and 0.006 in. and compressive yield strengths in the transverse direction of 240, 170, and 160 kg. per sq.in., respectively.

The tests indicated that consistent results could be obtained, without undue care, on specimens thicker than 0.010 in. The results were in good agreement with those obtained by the pack method or the single-thickness method. The tests on thinner sheet were usually successful when the procedure described was carefully followed. The time required for these compressive tests was about the same as for tensile tests of equal precision. *Technical Note No. 1022*, April, 1946.

A Multiple Bridge for Elimination of Contact-Resistance Errors in Resistance Strain-Gage Measurements. Isidore Warshawsky. A multiple-bridge circuit is described which eliminates contact-resistance errors of the first order between the arms of the ordinary Wheatstone bridge. This circuit is applied to the elimination of the effects of contact-resistance variations that may occur in resistance strain-gage measurements made through switch contacts or slip rings. No additional wiring is required at the strain gages, and the number of slip rings need not necessarily be increased. The general theory is derived, and correct circuits and constructions are described. The methods allow considerable freedom in choice of circuit combinations and are applicable to multiple-point strain measurements, particularly on rotating shafts or propeller blades. Other applications of the multiple-bridge circuit are noted. *Technical Note No. 1031*, March, 1946.

Steady- and Intermittent-Flow Coefficients of Poppet Intake Valves. John D. Stanitz, Robert E. Lucia, and Francis L. Masselle. Flow coefficients of an intake valve, seat, and port combination were measured under steady- and intermittent-flow conditions. Tests were conducted at large (greater than 2 in. Hg) and small (less than 2 in. Hg) pressure drops over an engine-speed range of 800 to 3,600 r.p.m. The results of these tests indicated that (1) steady- and intermittent-flow coefficients increase slightly with increasing pressure drops across the valves; (2) the intermittent-flow coefficient is approximately equal to the average steady-flow coefficient at an engine speed of 800 r.p.m. but decreases with increasing engine speeds above 800 r.p.m.; and (3) the intermittent-flow coefficient decreases less with engine speed when the pressure drop across the valve is large. It is concluded that the calculated cylinder pressures based on steady-flow coefficients obtained with small pressure drops across the valve may be in error when large pressure differences exist across the valve, but that no appreciable error should be caused by using the steady-flow coefficient when the pressure difference across the valve is small. *Technical Note No. 1035*, March, 1946.

A Study of Combustion in a Flowing Gas. Mitchell Gilbert, Gordon Haddock, and Allen Metzler. The results of a preliminary study of combustion in flowing gases are given and apparatus for obtaining high rates of heat release per unit volume of combustion space is described. The principal feature of the combustion apparatus is an electrical element (Globar) mounted concentrically within a stainless-steel pipe. The annular space between the inner and outer elements serves as the combustion space.

Tests were made over a wide range of fuel-air ratios, inlet-mixture velocities, and electrical heat inputs, using propane gas as the fuel. The effect of these variables on the extent of combustion and mixture inflammability was investigated. The results obtained with the combustion tube are as follows: (1) The greater the surface-volume ratio, or the greater amount of heat addible to the gas stream, the greater the inlet-mixture velocity at which appreciable combustion can be obtained. (2) For a given fuel-air ratio, the total rate of heat output (B.t.u. per sec.), equal to the sum of the electrical and chemical energy released, increases with increasing velocity. However, both the extent of combustion, as measured by the combustion factor, and the total heat output (B.t.u. per lb. of fuel) decrease with increase of velocity for most of the fuel-air ratios tested. (3) The most inflammable mixtures, as determined by the length of heating element necessary to produce ignition, are those of approximately stoichiometric proportions of fuel and air. *Technical Note No. 1037*, April, 1946.

Structural Hinge-Moment Increments Caused by Hinge-Axis Distortion. John V. Becker and Morton Cooper. An investigation of elevators having three hinges has been made to evaluate the structural hinge-moment increments resulting from changing the elevator angle when the hinge axis is distorted under load. An equation is derived relating the structural hinge-moment increment to the elevator angle, to the structural stiffness factors of the elevator and stabilizer, and to the amount of hinge-axis distortion. The analytic results are compared with test data obtained for a full-scale semispan fighter-type horizontal tail surface in the Langley 16-ft. high-speed tunnel. It is shown that the structural hinge-moment increments increase the control forces required to produce given elevator deflections. For large tail loads the structural hinge-moment increments are an appreciable fraction of the total hinge moment. *Technical Note No. 1038*, April, 1946.

Quantitative Treatment of the Creep of Metals by Dislocation and Rate-Process Theories. A. S. Nowick and E. S. Machlin. An equation for the steady-state rate of creep is derived by applying the theory of dislocations to the creep of pure metals. The form of this equation is in good agreement with empiric equations describing creep rates. The theory was also used to predict the dependence of steady-state rate of creep on physical constants of the material, and good agreement was obtained with data in available publications for pure annealed metals. The rate of creep was found to decrease with increasing modulus of rigidity. This fact suggests that one of the requirements for a heat-resisting alloy is that its matrix be a metal that has high modulus of rigidity and, therefore, a high modulus of elasticity. *Technical Note No. 1039*, April, 1946.

Effect of Mach and Reynolds Numbers on Maximum Lift Coefficient. John R. Spreiter and Paul J. Steffen. A compilation has been made of maximum-lift-coefficient data obtained in flight with six pursuit-type airplanes embodying typical conventional and low-drag airfoils. These flight data, which cover a range of Mach Numbers from 0.15 to 0.72 and of Reynolds Numbers from 4,400,000 to 19,500,000, have been analyzed together with pertinent model and airfoil data obtained in several wind tunnels.

It was found that the maximum lift coefficient varied with Mach Number down to Mach Numbers of approximately 0.15. When the effects of Mach Number were considered, as well as those of Reynolds Number, good correlation was found to exist between flight data and available wind-tunnel data, providing buffeting or other factors did not prevent attainment of the actual maximum lift coefficient. The same considerations provided good agreement among limited airfoil data from various wind tunnels.

At subcritical Mach Numbers, the maximum lift coefficient decreased steadily with increasing Mach Number for all airplanes tested. The effects of Reynolds Number were determined for three of the airplanes and found to be qualitatively as described in *N.A.C.A. Report No. 586;* quantitatively, the effects of Reynolds Number on the maximum lift coefficient decreased progressively with increasing Mach Number, becoming nil at a Mach Number of approximately 0.55. The critical Reynolds Number increased nearly linearly with Mach Number.

In the supercritical Mach Number range, the maximum lift coefficient of

conventional airfoils continued to diminish with increasing Mach Number, while that of the low-drag airfoils reached a minimum at a Mach Number between 0.40 and 0.55 and began increasing until secondary peak values were reached at a Mach Number between 0.60 and 0.66. At supercritical Mach Numbers, no effects of Reynolds Numbers were apparent for two of the three airplanes on which pertinent data were obtained. On the third airplane the maximum lift coefficient was affected by Reynolds Number but the phenomenon appeared to be basically different from that experienced at subcritical Mach Numbers. *Technical Note No. 1044*, March, 1946.

Tail Design Requirements for Satisfactory Spin Recovery. Anshal I. Neihouse, Jacob H. Lichtenstein, and Philip W. Pepoon. The design requirements for airplane tail surfaces that would make recoveries from spins in a satisfactory manner have been investigated in an analysis of the characteristics of models of approximately 100 military airplanes. In the analysis, the relative distribution of mass along the wings and fuselage and the relative density of the airplane were considered, as well as the design of the vertical surfaces.

A chart is presented that shows an empiric relationship between a tail-damping power factor and the relative density and mass distribution for satisfactory spin recovery. A formula for computing the tail-damping power factor also is given.

It is concluded that, if a designer provided a tail-damping power factor of 600 by 10^{-6} for airplanes for which the relative density at the spin altitude was not greater than 20, the probability that the airplane would have satisfactory recovery characteristics over a wide range of mass distribution by reversal of rudder and elevator would be extremely great. For larger values of relative density, larger values of tail-damping power factor would be required. *Technical Note No. 1045*, April, 1946.

Preliminary Wind-Tunnel Investigation at Low Speed of Stability and Control Characteristics of Swept-Back Wings. William Letko and Alex Goodman. Tests were conducted on untapered constant-span wings of 0°, 30°, 45°, and 60° sweepback. The purpose of these tests was to investigate the effect of sweepback on stability and control characteristics.

The data showed large changes in longitudinal stability at moderate lift coefficients for the 45° and 60° swept-back wings. The lateral stability, the slope of the lift curve, and the effectiveness of the aileron and the split flap at small angles of attack varied with angle of sweepback about as much as would be expected from simple theoretic considerations. Spoilers were much less effective than would be indicated by simple theory.

All the swept wings with flaps neutral reached a maximum value of about 20° effective dihedral at some lift coefficient. Drooping the wing tips decreased the slope of rolling-moment curve plotted against angle of yaw. Because the reduction increased with increase in lift coefficient, drooping the tips appeared to be a promising means of reducing the unfavorable lateral stability characteristics of wings with large sweepback.

The ailerons were capable of trimming out the rolling moment caused by only small angles of sideslip for the highly swept-back wings. The small change in pitching moment caused by aileron deflection indicated that wing-tip elevators having swept-back hinge lines would be relatively ineffective on highly swept-back wings.

The maximum lift with flaps neutral remained about the same for all angles of sweepback. The increment of maximum lift caused by the split-flap deflection decreased with angle of sweepback to approximately zero for the 60° swept-back wing. *Technical Note No. 1046*, April, 1946.

Two-Dimensional Wind-Tunnel Investigation of Low-Drag Vertical-Tail, Horizontal-Tail, and Wing Sections Equipped with Sealed Internally Balanced Control Surfaces. Albert L. Braslow. A two-dimensional wind-tunnel investigation was made of three low-drag airfoil sections equipped with sealed, internally balanced control surfaces designed for use as vertical-tail, horizontal-tail, and wing sections. The tests included determination of control-surface effectiveness and hinge moments and airfoil-section drag characteristics. Balance pressures also were measured for use in estimating the hinge-moment characteristics of the control surfaces with any amount of sealed internal balance.

Sharp irregularities occurred in the variation of the control-surface section hinge-moment coefficient with airfoil section angle of attack, which were probably caused by sudden movements in transition along the surfaces of all three airfoils at the extremities of the low-drag range. Tests of the vertical-tail section indicated that these irregularities were reduced in magnitude when transition was fixed at a forward chordwise position but were not entirely removed until transition was fixed at the airfoil leading edge. An estimated variation of aileron wheel force with wing-tip helix angle for an assumed airplane indicated that no unusual aileron wheel-force characteristics would be caused by the irregularities in the two-dimensional hinge-moment characteristics. Sudden movements in transition along the surfaces of vertical-tail or horizontal-tail sections, however, would probably cause sudden changes in rudder or elevator hinge moments. *Technical Note No. 1048*, April, 1946.

Wind-Tunnel Calibration of Free-Air Temperature-Measuring Devices for Use in Flight. David B. Stevenson. A memorandum report prepared for the Bureau of Aeronautics of the Navy Department gives the results of experiments with five pairs of temperature-measuring devices calibrated over a large range of speed in the N.A.C.A. 24-in. high-speed tunnel. The work was based on earlier discoveries for the direct measurement of the temperature of the free air surrounding an airplane in flight by orienting two similarly constructed and specially designed temperature probes in opposite directions with respect to an air stream. By connecting the junction leads of both instruments so that their electromotive forces were in opposition, a linear variation of the thermoelectric power with the square of the flight speed could be obtained over a large range of speed.

The apparatus is described and the results are presented in seven tables, a sketch, and ten graphs. *Compressibility Research Division, Langley Memorial Aeronautical Laboratory.*

National Research Council

National Research Council Organization and Members, 1945–1946. A booklet of 91 pages reviews the activities of the National Research Council and contains directories of the organization and personnel of its various sections for the year July 1, 1945, to June 30, 1946. It lists the names of the officers and executive board for that term, and the personnel of the committees and divisions of the Council. The provisions of the National Research Fellowships are set forth briefly and the members of the committees dealing with these Fellowships are named, as well as the recipients of the Fellowships for 1945–1946.

An alphabetical index of the personnel of the Council and an alphabetical index to the divisions and committees occupy the concluding pages of the booklet.

Navy Department

The Role of the Naval Air Transport Service in the Pacific War. Statistics with regard to the services performed by the Naval Air Transport Service are given in a loose-leaf booklet. The general subjects are indicated by index tabs classifying the history of the organization, its participation in the evacuation of ill and wounded naval personnel, the executive organization of the unit, the routes traversed, and figures regarding the tonnage of supplies transported. It is indicated that, although only a small proportion of the total tonnage of naval supplies during the war was transported by air, the important function of the Naval Air Transport Service was found in the saving of

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time and in the recovery of time that would otherwise have been lost in the delivery of vital supplies to the battle fronts. The statistical data are summarized in charts and tables in the concluding section of the booklet. *Naval Air Transport Service*, November, 1945.

Securities and Exchange Commission

Survey of American Listed Corporations. Part II. Prepared by the Securities and Exchange Commission, the report gives data on profits and operations for 1943–1944. It is compiled from registration statements and annual reports of companies having securities listed and registered on national securities exchanges, and is classified according to the industries in which the companies operate. The section on aircraft and aircraft equipment gives consolidated financial summaries of 35 companies manufacturing aircraft and equipment, their net sales, operating profit, expenses, reserves, intangible assets, and net worth before and after income taxes. Net profit is computed as a percentage of net worth. A financial statement for each of the companies shows the analysis in detail, with appropriate footnotes. Although the figures are for a period extending only to the end of 1944, they provide an authoritative background of financial information that will be useful to indicate the effects of the great expansion of aircraft companies during the war. *Securities and Exchange Commission*, Washington, D.C.

British Information Services

Note on Flight Tests on the Effect of Slipstream on Boundary Layer Flow. A. D. Young and D. E. Morris. Transition-point measurements have been made on an Anson and on a Courier at various stations inside and outside the slipstream, both in level flight and while gliding with engine throttled back. The main object of these tests was to investigate the effect of a large change in propeller working conditions on the position of the transition point in the slipstream. In neither case was there any marked difference between the transition-point positions in the slipstream in level flight and in the glide.

On the Anson at 160 m.p.h. it was found that in the slipstream the boundary layer remained laminar for a distance varying from 6 per cent to 10 per cent of mean chord length, while well outside the slipstream transition occurred at 17 per cent. Immediately outside the slipstream there was a region of disturbed air about 4 per cent thick where transition occurred at about 11 per cent. On the Courier at 140 m.p.h. transition occurred at about 5 per cent in the slipstream and at 25 per cent well outside the slipstream. These results are discussed and it is suggested that, in general, on smooth wings with conventional sections, transition will occur in the slipstream within the range 5 to 10 per cent of mean chord length. *Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 1957.* British Information Services, New York, $0.60.

Stalling Tests on a Blenheim. G. E. Pringle. In extension of earlier flight tests it was required to investigate how accidental stalling and spinning of a Blenheim is affected by the setting of wing flaps, cowl flaps, and throttles. The behavior of the aircraft was tested at low speeds, both in straight stalls and also when climbing with one engine inoperative. The tests included an investigation of some modifications to the wing.

It is found that all of the flap settings affect the behavior of the Blenheim at and near the stall; closing the cowl flaps and opening the throttles usually has an adverse effect, either by reducing the warning of imminent stalling or by making the stall more violent. With cowl flaps closed and throttles partly open the stall is violent with wing flaps and landing gear either up or down. In the single-engine tests the aircraft drops the corresponding wing suddenly, and at the lower speeds the falling wing partially stalls. The experiments with modified wing-section and wing-tip plan form resulted in some improvement in stalling behavior after cutting one engine. *Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 1966.* British Information Services, New York, $0.75.

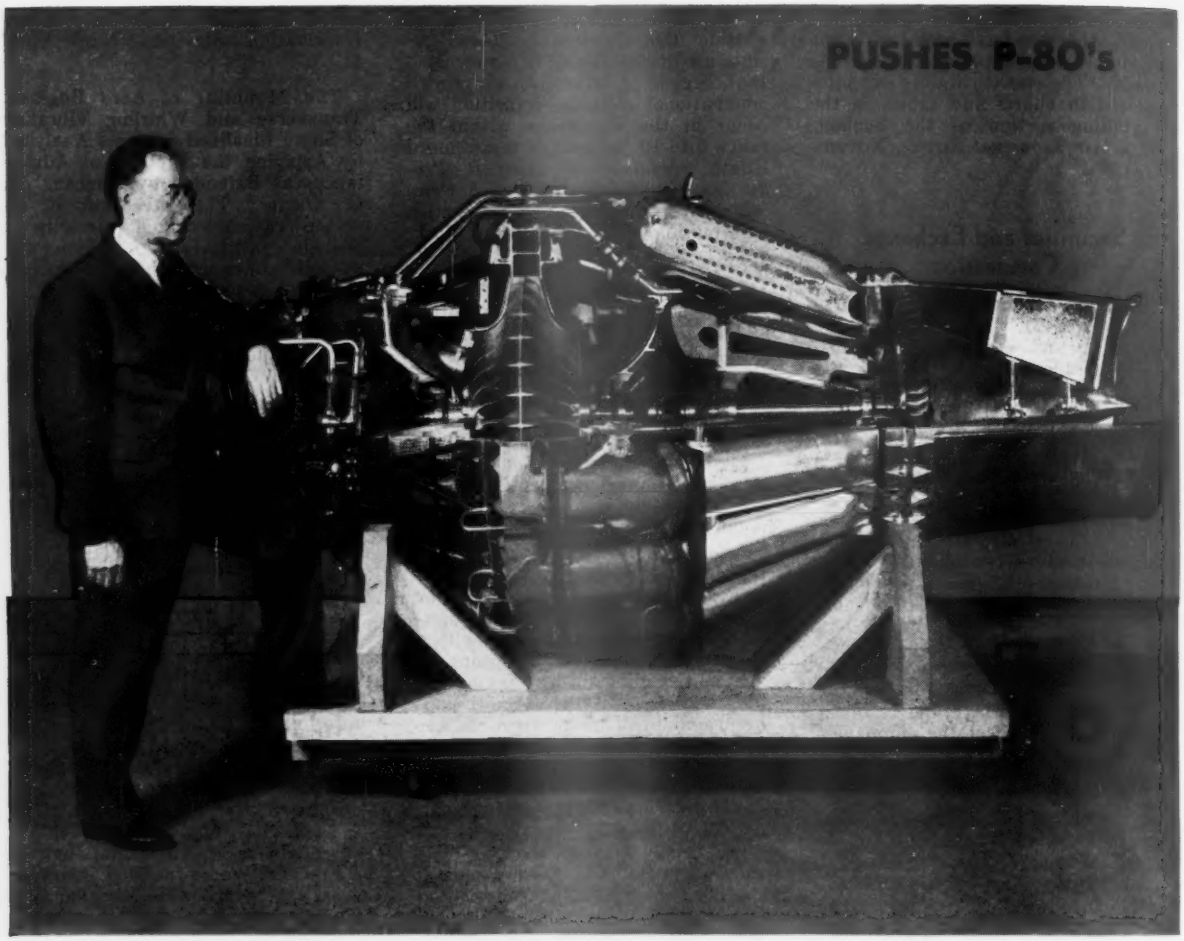
Round Jets in a General Stream. H. B. Squire and J. Trouncer. The flow in and near a jet with an external stream parallel to the jet axis is considered with special reference to the inflow induced outside the jet. The fluid is assumed to be incompressible, but the application to jets of heated or compressible fluids is briefly considered. The flow in a round jet issuing from an orifice in the same direction as a general external stream is investigated theoretically as an extension of the problem of a jet issuing into still air. The flow in the upstream part of the jet in which a core of fluid of uniform velocity exists, and the flow in the downstream or developed part of the jet are investigated separately; the two solutions are then jointed at the section at which the core disappears, and in this way a complete picture of the development of the jet is obtained. The deviation of the outside stream attributable to inflow into the jet also is considered. Numerical solutions are derived for several values of the ratio of jet exit velocity to stream velocity. *Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 1974.* British Information Services, New York, $1.35.

The Mounting of Aero Engines: Transverse and Whirling Vibration of Some Idealised Systems Analysed by Applying the Method of Admittances as Extended by Duncan. B. C. Carter. The investigation reported was undertaken primarily to provide a rational design basis for the mounting of engines in single-engined aircraft. An analysis is made of the flexural vibrations of a uniform beam having a spring-supported mass at one end, the whole system being free in space, which is analogous to an engine flexibly mounted at the end of the fuselage. Special conditions examined include "de-coupling" spring mountings, gyroscopic coupling effects of propeller inertia, and the case of an overhung mass. The results are applied to a Defiant I type of airplane, using experimental data. The analysis is extended to include cable-hanger systems.

It is concluded that when the equivalent uniform beam is known, the method provides a rational quantitative basis for engine-mounting design. The ability to assess the equivalent uniform beam in new applications will increase with use of the method in relation to experimental observation. When the equivalent system has been determined, the method should serve for predicting quantitatively the effects of changes in the engine mounting and also for showing how damping may be introduced in an effective manner.

The analysis affords a method of examining the mounting conditions provided by a cable-hanger and of comparing it with mounting conditions in aircraft. Data for applying the method of admittances to new designs of aircraft can be obtained experimentally by making forced-vibration observations on a number of representative aircraft. *Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 1988.* British Information Services, New York, $2.25.

The Effect of Differing Thickness Distributions on a Propeller's Efficiency. A. B. Haines. The note describes the results of an investigation made to determine the effect of the thickness-to-chord ratio on the propeller efficiency. It covers a range of forward speeds up to the highest envisaged for conventional propeller-driven aircraft. Five propellers of differing thickness-to-chord ratio are considered, and an attempt is made to obtain the optimum conditions for each propeller. Calculations of the efficiency of propellers having five different thickness distributions (effects of other variants having been eliminated) have been made for forward speeds from 300 to 600 m.p.h. at 20,000 ft. It is shown that the efficiency becomes extremely sensitive to the thickness (particularly of



"The jet age is here"

—says R. G. Standerwick, General Electric engineer, as he shows reporters a cutaway of the powerful I-40 engine developed by G.E. for the Lockheed *Shooting Star*. He added, "civilians are certain to benefit from these new power developments in the relatively near future." Mr. Standerwick made these comments after receiving the news of the record-breaking flight by three Army P-80's across the United States in less than five hours.

The non-stop flight of 4 hours, 13 minutes, and 26 seconds made by one of the planes "just cruising", was proof of the tremendous power and efficiency of jet propulsion. However, in commercial planes the combination of gas-turbine propeller drive and a typical jet engine such as the I-40 for additional thrust will probably prove even more efficient. Planes powered in this manner should prove popular with passengers, for there is virtually no vibration. This and other features combined with fuel economy and speed such as cannot be obtained with reciprocating engines will truly mean a new age in commercial aviation. G-E engineers, continuing development work in this field, will be glad to discuss the possibilities of jet propulsion with you. *Apparatus Dept., General Electric Company, Schenectady 5, New York.*

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the root end of the blade) as the speed is increased beyond 500 m.p.h., but that at this speed the effects of tip thickness are relatively minor, provided the blade is at least as thin as, for example, a modern compressed-wood propeller. *Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 1992.* British Information Services, New York, $0.60.

Measurement of Hinge Moments and Pressure Plotting on a Swordfish Rudder in the 24-ft. Tunnel. R. A. Shaw and D. White. Because of the violent oscillation of the rudder and failure of the horn balance on a Swordfish in flight, an investigation into the loads acting on the rudder was required. Hinge-moment and pressure-distribution tests were made on a full-scale Swordfish rudder, fitted to a dummy fuselage in the 24-ft. tunnel. Measurements were taken over the full range of rudder angle at various angles of sideslip.

The violent oscillation reported in flight could not be reproduced in the tunnel, and the hinge moments showed no instability.

A maximum suction was measured at a point near the leading edge of the horn, and the mean pressure on sections of the rudder through the horn was 40 to 45 per cent greater than on the rudder as a whole. The mean normal force coefficient for the rudder reached a value of 66 per cent at 5° positive sideslip and 20° negative rudder angle. *Ministry of Aircraft Production, Aeronautical Research Committee, R. & M. No. 1976.* British Information Services, New York, $0.60.

Properties of Characteristic Numbers and Modes Deduced by Matri-Methods. W. J. Duncan and Olga Todd. In many physical and geometric problems the coefficients of a set of homogeneous and linear simultaneous equations depend on a given parameter, and it is required to find the values of that parameter which render the equations compatible. The topic of this paper is the nature of these "characteristic numbers" or "latent roots" and of the corresponding sets of solutions or "modes." Most of the propositions discussed are well known and the paper is mainly intended to illustrate the simplicity and conciseness of matrix methods, and to demonstrate an almost uniform method of treatment. An almost uniform method of proof is adopted but no attempt at an exhaustive treatment is made. *Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 2006.* British Information Services, New York, $1.05.

The Experimental Determination of the Two-Dimensional Interference on a Large Chord Piercy 12/40 Aerofoil in a Closed Tunnel Fitted with a Flexible Roof and Floor. J. H. Preston, N. E. Sweeting, and D. K. Cox. The purpose of the investigation was to test the construction of flexible walls on a fairly large scale in connection with the proposed two-dimensional tunnel, and to furnish information about the interference on airfoils and controls whose characteristics depart appreciably from theoretic values for potential flow (Joukowski circulation), thus extending the work carried out in *R. & M. No. 1997.*

The construction of flexible walls on a large scale is practicable and their operation satisfactory when set to the computed streamlines appropriate to the wing in an unbounded stream. In particular for the ratio of effective chord to tunnel height of 0.453, the ratio of the lift with straight walls to that with curved walls is 1:10, which agrees with that deduced from Goldstein's theory. The pressure (or velocity) distribution at 0° incidence with interference removed agrees extremely well over most of the airfoil with that for potential flow past the airfoil in an infinite stream, and the effect of interference is in good agreement with that computed by replacing the airfoil by its "equivalent doublet." Further, the center of pressure with no interference agrees with that obtained on a small-chord airfoil in the compressed-air tunnel at the same Reynolds Number. The measured effect of interference is in the direction indicated by theory.

As regards the hinge moments, the effect of interference for the given chord-to-height ratio is small. The tests on smooth wings are unreliable and from tests with turbulence wires it would appear that the effect of removing the interference is to reduce slightly the degree of underbalance. This is in the direction indicated by theory but has no numerical relation to it.

A feature of the present tests, which have been made at small Reynolds Numbers, is the presence of laminar separation on the lower surface at all positive incidences, while on the upper surface there is no separation of the flow at all. Tunnel interference has no measurable effect on the position of laminar separation or on the position of the transition point. This laminar separation is responsible for lift and hinge moment curves that are nonlinear and are extremely sensitive to flow conditions. Turbulence wires straighten out the lift and hinge moment curves but the effect on the balance of the latter is opposite to that usually found for normal sections. In the present case the degree of underbalance is increased to such an extent as to suggest that the smooth-wing tests would be worthless for full-scale applications. It is therefore recommended, in tests on semilow drag or low-drag airfoils at low or moderate Reynolds Numbers, that visual observation of the flow at the surface be carried out and, if laminar separation is present, that hinge moment measurements be discarded for the tests on smooth wings. *Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 2007.* British Information Services, New York, $0.90.

Application of Thin Aerofoil Theory to the Design of Double Flap Controls of Small Chord. H. H. B. M. Thomas and M. Lofts. Recent experimental investigations on small-chord controls in two-dimensional flow suggest that such controls are more efficient than wide-chord controls. The experiments also suggest that a further gain is obtained if the control or flap is broken, hinged, and geared at some point along its chord. The note examines, on the basis of the thin airfoil theory, the control efficiency of such double-flap systems, as ailerons and as elevators. A range of values of total chord ratio is covered and the optimum arrangement determined in each case.

The theory suffers from the limitations of the thin-airfoil theory, which fails to take account of the thickness-to-chord ratio and the boundary-layer effects; these can be large for the thicker sections. It does, however, provide an indication of the effect of variants of the various parameters and also the ratio of the flap chords defining the optimum.

In general terms the problem considered is to find the minimum control-column force needed to produce a given rolling moment. Throughout the present work the lift is fixed at that produced by the 0.50 chord flap. It is shown that the smaller chord single- and double-flap systems are more efficient than a wide-chord arrangement, and that a double flap is more efficient than a single flap of the same total chord. *Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 2017.* British Information Services, New York, $0.60.

Spinning Tests on Fluttering Propellers. L. H. G. Sterne. The report describes a series of spinning tests made on a number of fluttering propellers on the No. 3 spinning tower at the Royal Aircraft Establishment. In each case the flutter was detected aurally and the critical flutter speeds at the various pitch settings at which the propellers were spun are recorded. Tests were made to determine the variations of the flutter characteristics between propellers with two, three, and four blades, between three propellers of the same design, and between a propeller when spun on an electric motor and on a reciprocating engine. Examples of blade failure in flutter are given.

It is concluded that heavy flutter, capable of causing structural failure, is liable to occur with compressed-wood blades whose ratio of thickness to chord is less than 10 per cent at the 70 per cent radius. *Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 2022.* British Information Services, New York, $0.90.

ALIKE AS TWO PINS?

Yes, or alike as two telephone handsets made by the same process. Yet, pins or handsets — no two could ever be made exactly alike. Dimensions, weight, performance — all vary every time due to variables in manufacture. How can these variables be *controlled*?

Back in 1924, Bell Laboratories' mathematicians and engineers teamed up to find out, forming the first group of quality-control specialists in history. They invented the now familiar Quality Control Chart, designed inspection tables for scientific sampling. They discovered that test data mathematically charted in the light of probability theory were talking a language that could be read for the benefit of all industry. Western Electric, manufacturing branch of the Bell System, applied the new science to its large-scale production. In war, it was used by industrial and government agencies of the United Nations in establishing and maintaining standards for military matériel. A Quality Assurance Department, a novelty back in the nineteen-twenties, has come to be indispensable to almost every important manufacturer.

Scientific quality control is one of many Bell Laboratories' ideas that have born fruit in the Bell System. The application of mathematics to production helps good management all over the industrial world — and furthers the cause of good telephone service.

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The Effects of Strategic Bombing on the German War Economy

Contents: Summary and Conclusions; German War Economy in Perspective; The Supply and Use of Labor; The Supply and Use of Capital Equipment; The Construction Industry; Basic Materials; Civilian Supply; German Armament Production.

A comprehensive report relates by means of text, statistical tables, and graphs the effects of the bombing of industrial Germany by the Royal Air Force and the U.S. Army Air Forces. It shows how much damage was done to various industries, transportation services, and the labor supply. The curtailment of the supply of basic materials is another important aspect of the bombing results. Probably the most complete study ever made public of air power as it affects the economy of an enemy, this and other such reports will be the basis of the formulation of military air policy for the future.

The appendix is a compilation of 115 tables showing German industrial statistics at various periods during the war and the results of air raids on many of the important industrial centers. U.S. Strategic Bombing Survey, Overall Economy Effects Division, Washington, D.C., 1945; 286 pages.

Aircraft Electricity for the Mechanic

Charles Edward Chapel

Contents: Fundamentals of Electricity; Direct-Current Circuits; Magnetism and Electromagnetism; The Aircraft Storage Battery; Alternating Current; Condensers; Electromagnetic Induction; Generators; Generator Control Systems; Motors; Ignition Systems; Aircraft Electrical Instruments; Engine Starting Systems; Lighting; Landing-Gear Circuits; Remote-Control Battery System; Electric Propeller-Control Systems; Wire Identification Systems; Wire-Connecting Devices; Wiring Practices; Wiring Diagrams; Junction Boxes; Bonding and Shielding; Heating Systems; Vacuum Tubes; Kirchoffs' Laws; Electrical Hazards and First Aid; Aircraft Electrical Inspections; How to Get a Job; Aircraft Maintenance Electrician's Tool Kit.

The original manuscript was used by the author, before printing, in teaching the principles of aircraft electrical ignition systems to officers and enlisted men of the Army, Navy, and Marine Corps, and civilian students, who were being trained to become pilots, maintenance supervisors, or mechanics. Lieutenant Chapel first explains the fundamental principles of operation, maintenance, and inspection, followed by their application and use. Troubles frequently encountered in actual operation are emphasized. The various possible causes of each of these troubles, and the symptoms by which they can be recognized, as well as the necessary correction in each case, are pointed out. The result is a practical course of home study. Illustrated with charts, diagrams, and pictures, the book is designed to prepare the reader for licenses and to offer instruction that is applicable to aircraft mechanics, pilots, ground-school teachers, airport technicians, and aircraft-factory employees. Typical examination questions, with keys to the correct answers, are placed at the end of each chapter. Coward-McCann, Inc., New York, 1946; 477 pages, $5.00.

With the exception of aeronautical annuals and books published outside the United States, books reviewed in this section may be borrowed without charge from The Paul Kollsman Library of the Institute of the Aeronautical Sciences, 2 East 64th Street, New York 21, N. Y.

Air Traffic Control

Glen A. Gilbert

Contents: Development of Air Traffic Control; Present Air Traffic Control System in Continental United States; Operation of Airway Traffic Control Centers; Operation of Airport Traffic Control Towers; Methods of Air Traffic Control Outside Continental United States; Limitations of Present Air Traffic Control Systems; Improvements Planned by United States; Air Traffic Development; Airports and Air Traffic Control; Blueprint for the Future.

The author presents a book written to provide a textual treatment of the existing systems of air-traffic control and a guide to assist in the planning for future problems. The history and development of air-traffic control is traced. Consideration is given to the air-traffic control system now used in the United States, its limitations, and means of improving it. Future requirements for air-traffic control systems are discussed. Ziff-Davis Publishing Company, New York, 1945; 274 pages, $5.00.

Principles of Sound Control in Airplanes

Leo L. Beranek, Rudolph H. Nichols, Jr., H. Wayne Rudmose, Harvey P. Sleeper, Jr., Robert L. Wallace, Jr., and Harold L. Ericson

Contents: Part I, Estimation and Measurement of Sound Levels in Airplanes: Object; Procedure and Apparatus; Estimation of Sound Levels and Spectra in Airplanes; Measurements of Sound Levels and Spectra in Eighteen Types of Airplanes at Normal Cruising Flight Conditions; Variation of Sound Levels and Spectra as a Function of Position in the Airplane; Variation of Sound Levels and Spectra as a Function of Flight Conditions; Variation of Sound Levels and Spectra as a Function of Different Propeller and Exhaust Conditions; Variation of Sound Levels and Spectra as a Function of Wind Leaks Around Doors, Windows, Hatches, and Turrets, and of Ventilator Design; Variation of Sound Levels and Spectra as a Function of Altitude; The Effect of Noise on Communications and Psychomotor Efficiency.

Part II, Materials for Sound Control in Airplanes: Object; Introduction; Sound Transmission Through Impervious Structures; Sound Transmission Through Absorptive Structures; Sound Absorption by Various Structures; Sound Absorption as a Function of the Properties of Trim Cloths; Flow Resistance of Fibrous Materials.

Part III, Practical Procedures for Sound Treating Airplanes: Factor of Basic Design Affecting Sound Levels; Procedure for Design of Acoustical Treatment for Flight Deck of a Hypothetical Bomber; Additional Information Pertinent to the Sound Treatment of Airplanes; Conclusions; Collected Computational Charts and Tables.

The report gives procedures for estimating sound levels in airplanes

and outlines methods for choosing and mounting windows and acoustical materials for maximum sound reduction. Pertinent data to verify the conclusions are included. The analytic information set forth in the first two parts of the report is further explained in a third section devoted to practical procedures for soundproofing of airplanes. Appendixes contain fundamental data about properties and measurement of sound; apparatus for measuring sound transmission, absorption and flow resistance; tabulation of transmission characteristics for measured acoustical structures; letters of authority (manufacturers' releases) for data published. A separate booklet titled *Summary of Principles of Sound Control in Airplanes* contains cartoon-type illustrations and topical text titles emphasizing the causes of noises in airplanes. Research on Sound Control, Cruft Laboratory, Harvard University, Cambridge, Mass., 1944; 388 pages.

Book Notes

My Three Years with Eisenhower, by Capt. Harry C. Butcher; Simon and Schuster, New York, 1946; 911 pages, $5.00.

Those interested in General Eisenhower's command of both the American and British air forces will be rewarded by checking through their particular interests in the voluminous index to this 900-page book. From it they will learn the great importance the commanding general of the combined military and naval forces in the European theater of operations assigned to the air offensive, particularly to strategic bombing. Page after page mentions conferences with Generals Arnold, Spaatz, Eaker, Doolittle, and many others including the heads of the Royal Air Force. The sidelights of these meetings are given by Captain Butcher, who was probably the closest friend of his chief. The fine personal qualities and great ability of the Supreme Commander of the Allied Expeditionary Forces are revealed on almost every page of this inside record of the day-to-day events in the wartime career of a historic leader.

The Case Against the Admirals, by William Bradford Huie; E. P. Dutton & Company, Inc., New York, 1946; 216 pages, $2.50.

Probably the most provocative book ever written on the United States' policy is W. B. Huie's attack on the old-line generals of the Army and admirals of the Navy. Intended to be controversial, this book by the author of *The Fight for Air Power* hits right and left at what he considers reactionary policies, restrictions, and duplications, all of which he believes can be overcome by a unification of the Army, Navy, and Air Forces, giving to each equal rank under a single civilian head.

The Army pilots who have been fighting for their chosen branch of the military service are quoted freely, particularly Major Gen. Hugh Knerr. All of the arguments that have been used by the Army in favor of unification are given in such forceful style that the book is bound to have repercussions from Navy officers who have opposed the plan.

Either it will give a strong lift to the unification proposal of President Truman, or, its own vitriolic attack showing that the subject is the cause of heated discussion, it will suggest that the merger should be postponed until the whole plan may be more calmly considered.

One World or None, edited by Dexter Masters and Katharine Way; Whittlesey House, McGraw-Hill Book Company, Inc., New York, 1946; 79 pages, $1.00.

The clearest statements yet made about atomic power, its effects, and how it may influence future warfare are expressed in this definitive and authoritative analysis of the many problems created by the advent of the atomic bomb.

General Arnold and a group of outstanding scientists and writers present a round-table discussion of the full meaning and terrifying dimensions of the bomb's threat to world survival. They warn that full appreciation of the implications of nuclear energy is the responsibility of every citizen.

A reading of this short symposium will give every reader the essential facts that he should know in order to form an opinion about the new force and its danger to civilization.

Guy Gilpatric's Flying Stories; E. P. Dutton & Company, Inc., New York, 1946; 287 pages, $2.50.

Some of the best stories about aviation have been written by this old-time pilot, who weaves his knowledge of early flying and pioneer pilots into a series of tales of adventure, romance, and heroism. The book will bring back pleasant memories to old-timers and make known to the new generation how the flying "game" was run by the men who were willing to fly any kind of machine for fame, fortune, and experimentation.

As Gilpatric is an experienced writer in other fields, he knows how to develop story interest. Having actively participated in the early flying in this country he writes from personal knowledge. The result is a succession of interest-holding chapters.

The Development of Mathematics, by E. T. Bell; McGraw-Hill Book Company, Inc., New York, 1945; 637 pages, $5.00.

A book written to meet the requests of students and instructors for a broad survey of the general evolution of mathematics. It is not a history of the traditional kind but a narrative of the decisive epochs in the development of mathematics. About 50 pages have been added to this second edition of the book. The additions include numerous short amplifications of miscellaneous topics from Greek mathematics to mathematical logic, with longer notes on symbolism, algebraic and differential geometry, lattices, and other subjects in which there have been striking recent advances.

Wheeler's Aviation Books: Flying Questions; Carlton L. Wheeler, Penn Yan, N.Y., 1946.

Fundamentals of Flight, 62 pages, $1.00. This manual begins with the theory of flight and explains the proper procedure for 40 or more flight maneuvers. Approved C.A.A. ground and flight instruction is outlined, enumerating the subjects and maneuvers to be learned in the three stages of training.

Elementary Study Guide: Meteorology, 94 pages, $1.00. Written in simple language, the purpose of this manual is to give a good working knowledge of the subject in a few hours of study, by a question-and-answer method. Seven hundred questions are submitted for the student to answer and a key to many of the answers is supplied. Other answers are to be found in corresponding C.A.A. bulletins. The 30 questions in the Private License examination are included in the first four sections of the book, and the 50 Commercial License examination questions are incorporated in the other parts of the book.

Elementary Study Guide: Navigation, 86 pages, $1.00. Prepared for use with Civil Aeronautics Bulletins, 500 problems and questions are presented. Some of the answers are supplied in an answer key which accompanies the manual, while the others can be found in C.A.A. Bulletin No. 24. Questions and problems deal with Pilotage, Dead Reckoning, and Radio Navigation. Questions given in both Private and Commercial License Examinations are included.

Ground Instructor's Handbook, 128 pages, $2.50. This manual, revised and reprinted in 1946, offers the instructor 3,800 questions, furnishing material for both elementary and advanced examinations. Included are multiple-choice fill-in statements, and true-and-false sentences. The subjects covered are Civil Air Regulations, meteorology, aerial navigation, general service of aircraft, aerodynamics, and theory of flight and engines.

Radiotelephone Operation, 40 pages, $1.00. The main features in this manual deal with (1) the Radiotelephone Operator's Permit examination as given by the Federal Communications Commission; (2) radiotelephone procedures for proper transmission of messages, their composition, and examples of communications with both airport control towers and C.A.A. Communications Stations; proper methods of using radiotelephone equip-

ment; enunciation, use of numerals, and the phonetic alphabet, fully explained in text and question-and-answer form; (3) instructions and diagrams pertaining to hand signals and colored lights for direction of airport and landing traffic; (4) a discussion of radio navigation, with one method of orientation explained. (5) Civil Air Regulations applying to instrument flight are listed in the last section of the book.

Parachutes, 56 pages, $2.00. Material is supplied for the purpose of aiding in the preparation for examinations for the Parachute Technician's Certificate of Competency. This examination is divided into four parts: Civil Air Regulations; inspection and repair of parachutes; packing procedures; and use of parachutes. Procedures are given for inspection, repair, maintenance, and use of Switlik, Pioneer, Irvin, and U.S. Army parachutes. Parts of the Civil Air Regulations and pertinent extracts from C.A.A. and C.A.B. bulletins also are included for study.

Elementary Study Guide: General Service of Aircraft, 98 pages, $1.00. Prepared for use with Civil Aeronautics Bulletin No. 23, questions are grouped under the following headings: theory of flight; inspection and care; instruments; parachutes; load factors; general service of aircraft; and airplane stresses. Others are airplane materials; standardization; fastening; construction; assembly; and maintenance. An answer key is provided for some of the questions.

Pre-Flight Aeronautics Study Guide, 180 pages, $1.00. The material, divided into the four subjects of General Service of Aircraft, Meteorology, Air Navigation, and Civil Air Regulations, has been arranged in 40 lesson assignments, each of which contains a set of questions to be used as preparation. The last assignment in each subject is a multiple-choice test covering that subject. The last two assignments are a comprehensive review of all four subjects and a simulated private pilot's examination. Answers to some of the questions are supplied.

Simulated Commercial Pilots Examination, 22 pages, $0.50. *Simulated Private Pilots Examination,* 4 pages, $0.15. Reproductions of typical examinations submitted to candidates for Commercial Pilot's License and Private Pilot's License are offered for sale.

The Phase Rule and Its Applications, by Alexander Findlay; Dover Publications, New York, 1945; 319 pages, $2.75.

The eighth edition of a work in which an entirely nonmathematical exposition of the Phase Rule is presented. Certain obsolete sections have been discarded or rewritten, and corrections in the data have been made in the light of recent investigation.

Encyclopedia of Chemical Reactions, compiled and edited by C. A. Jacobson; Reinhold Publishing Corporation, New York, 1946; 804 pages, $10.

Volume I of a set of reference books on chemical reactions is devoted to aluminum, beryllium, antimony, bismuth, arsenic, boron, barium, and bromine reactions. It represents the first step in the author's effort to assemble all available material on inorganic chemical reactions into one complete set of books for the use of those engaged in research, teaching, and technical laboratory work.

From the Ground Up, by Sandy A. F. MacDonald; Aviation Service Corporation Ltd., Toronto, Ontario, 1942; 72 pages, $1.00.

The third edition of this pilot's manual, based on the ground-school syllabus of the British Commonwealth Air Training Plan, includes text and explanatory diagrams of the following subjects: Elementary Air Navigation; Theory of Flight; Meteorology; Engines; Airframes; and Airmanship.

World Air Control Board, by Sir Frank Clarke; Robertson & Mullens, Melbourne, Australia, 1944; 97 pages, 4*s.* 6*d.*

A small book, written in 1944, which attempts to provide for statesmen of all nations who devise the peace treaty of World War II, a suggested method for the abolition of the War Plane from future wars. The book purports to be written 11 years after the end of the war because the author feels that this perspective is more effective than writing in the future tense. His desire is to have statesmen read this document with the idea of testing each link. His faith lies in the fact that the Air Control Charter method does not depend on any nation's support, ideology, or statecraft, but on a natural function of a body operating a universal service in peacetime with a secondary commission to prevent the beginning of aerial war anywhere. It does not attempt to affect any other branch of warfare or to provide an international force of warplanes.

Rubber in Engineering; Chemical Publishing Company, Inc., Brooklyn, 1946; 267 pages, $5.50.

Prepared under the direction of the Controller of Chemical Research of the British Ministry of Supply and the Directors of Scientific Research of the Ministry of Aircraft Production and the Admiralty on the basis of research carried out by the Imperial Chemical Industries, Ltd., the book has been designed to provide engineers with a general survey of the information available on the fundamental properties of rubber. A considerable proportion of the text has been devoted to the theoretic aspects of the subject, although these chapters are so grouped that readers who are more interested in the practical applications can omit them. The book is not intended to be a practical working guide to the design of particular rubber components, but rather as an exposition of underlying principles. The subject has been treated generally on the basis of a number of years of experience with the types of problems posed for those who are interested in both the manufacture and use of rubber articles. It was reprinted by permission of the Controller of His Britannic Majesty's Stationery Office.

Electrons in Action, by James Stokley; Whittlesey House, McGraw-Hill Book Company, Inc., New York, 1946; 320 pages, $3.00.

In a book for nontechnical readers the author gives an account of what electrons are and where they come from. The pioneering work in this field is described. Frequency modulation and cosmic electronics are discussed. A picture is drawn of the part electronics play in industry. There are chapters on radar, loran, and the atomic bomb. Throughout the book the author stresses the opportunity that electronics offers to the young man who is starting a career.

Elements of Ammunition, by Major Theodore C. Ohart; John Wiley & Sons, Inc., New York, 1946; 412 pages, $6.00.

The author reviews his technical experiences with ammunition, for the period from 1940 to 1945, in an attempt to orient the beginner in ammunition design and developmental work in this field. The purpose of the book is not only to serve as a basic handbook for the ordnance engineer, but also to be a source of information for those whose work or interests call for the study of modern ammunition.

Testing of Engineering Materials, by Carl W. Muhlenbruch; D. Van Nostrand Company, Inc., New York, 1944; 200 pages, $2.75.

A textbook for a laboratory course in materials testing, written for the purpose of conveying an understanding of the physical properties of materials commonly employed in engineering design, their application based on such properties, and their limitations. Introductory material is provided with each experiment to acquaint the student with the problem of the experiment, as well as to give supplementary information helpful in interpreting the test results obtained. The applications of experimental results have been emphasized, whereas the techniques of testing procedures have been minimized. The purpose of an experiment is made clear to the student through actually conducting the experiment, with questions included.

Riveted Joints, by A. E. Richard de Jonge; American Society of Mechanical Engineers, New York, 1945; 250 pages, $4.50.

A critical review of the available publications on the development of riveted joints, together with a bibliography and abstracts of the most important articles on the subject. A supplement contains abstracts of addi-

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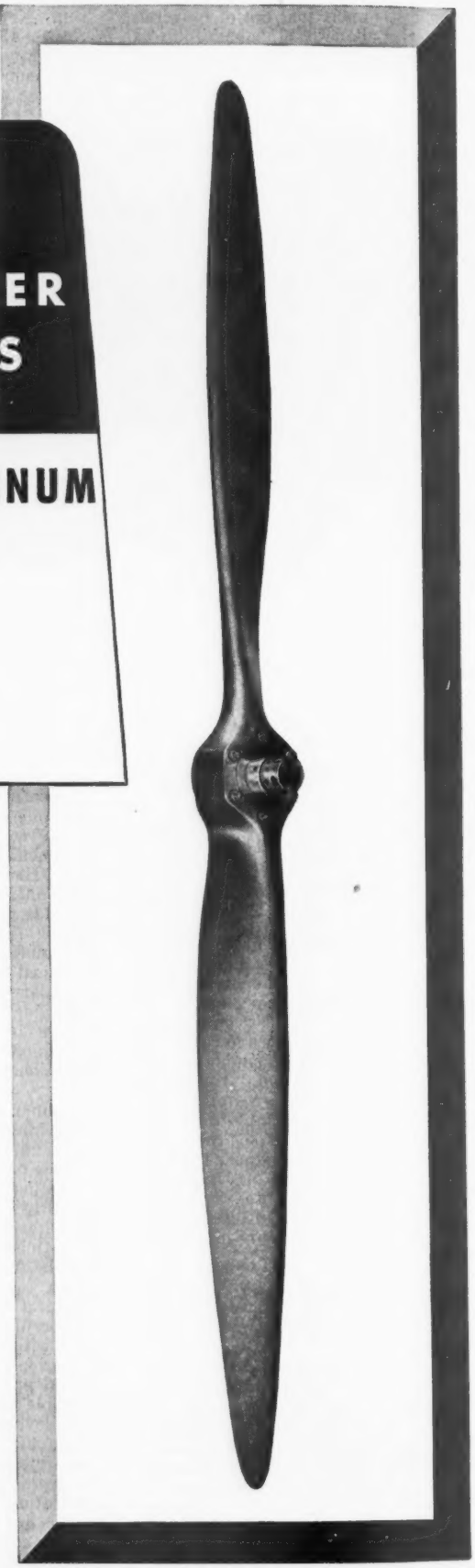

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tional articles that came to the author's notice after the bibliography was closed on December 31, 1940.

Electronics for Engineers, edited by John Markus and Vin Zeluff; McGraw-Hill Book Company, Inc., New York, 1945; 390 pages, $6.00.

For the convenience of design engineers, builders, and users of electronic equipment, 142 articles, reference sheets, charts, and graphs have been reprinted from the pages of *Electronics*. The material represents condensed information in graph and chart form which has been in demand for the reference use of engineers.

Hackh's Chemical Dictionary, edited by Julius Grant; The Blakiston Company, Philadelphia, 1944; 925 pages, $8.50.

The third edition of an encyclopedia type of chemical dictionary is offered in completely revised form. It contains over 57,000 entries, including words generally used in chemistry and many of the terms used in related sciences, including physics, astrophysics, mineralogy, pharmacy, agriculture, biology, medicine, and engineering. Numerous tables, diagrams, and illustrations are included.

The Naval Officer's Guide, by Arthur A. Ageton; Whittlesey House, McGraw-Hill Book Company, Inc., New York, 1946; 588 pages, $3.50.

Because naval organization and administration are in a continuous state of change, additional material has been added to the third edition of a guide for naval officers to bring it up to date. The book is intended to serve as a compendium of useful information for the guidance of the individual commissioned officer of the U.S. Navy.

Principles of Physics II: Electricity and Magnetism, by Francis Weston Sears; Addison-Wesley, Inc., Cambridge, Mass., 1946; 434 pages, $4.00.

The second volume of a series of texts written for a 2-year course in general physics at the Massachusetts Institute of Technology is devoted to electricity and magnetism. Because the book is intended for students who have had a thorough grounding in mathematics and physics, the subject of electricity and magnetism is developed on a somewhat higher level than in the usual college course in general physics. Problems are provided at the end of each chapter to aid the student.

1945 Supplement to A.S.T.M. Standards Including Tentatives, Part I, Metals; American Society for Testing Materials, Philadelphia, 1946; 397 pages, $4.00.

The supplement to Part I on Metals, of the 1944 book of A.S.T.M. standards, contains the newly adopted and revised standards, and the new and revised tentative standards, in the metals field, which have been accepted since the appearance of the *1944 Book of Standards, Part I*. Of the 28 standards, ten are newly adopted and 18 are replacements of existing standards. Of the 59 tentative standards, 44 are replacements, while the remaining 15 are published for the first time.

Aero-Economics, by James B. Kendrick; Graduate School of Aeronautics, California Institute of Technology, Pasadena, Calif., 1945; 74 pages.

Some of the many economic aspects of airplanes and air transportation are discussed as a means of showing the usefulness of analysis in this field. Because aeronautical research and development offer numerous problems involving compromise between performance, load capacity, structure, serviceability, and production schedules, the author presents information that should help to establish these problems in their order of relative importance and aid in the conduct of developmental activity and the design of more useful aircraft.

Polar Molecules, by P. Debye; Dover Publications, New York, 1945; 172 pages, $3.50.

A book that brings together the accumulated information on polar molecules and points out the gaps that still exist in theory and experiment. The introduction of the quantum theory makes it possible to develop in detail the connection between polarity and the phenomena of dispersion and absorption. The volume is a reprint of a book published in 1929.

Magnesium; American Society for Metals, Cleveland, 1946; 265 pages, $3.50.

The book contains a series of five educational lectures on magnesium which were presented to members of the American Society for Metals during the Twenty-Seventh National Metal Congress and Exposition, held at Cleveland, February 4–8, 1946. The titles of the papers and the lecturers are as follows: "Magnesium—Extractive Metallurgy," by L. M. Pidgeon; "Magnesium Structural Design," by John C. Mathes; "Magnesium Castings," by Norman E. Woldman; "A Survey of Wrought Magnesium Alloy Fabrication," by J. V. Winkler; "Corrosion and Protection of Magnesium," by W. S. Loose.

Industrial Algebra and Trigonometry, by John H. Wolfe, William F. Mueller, and Seibert D. Mullikin; McGraw-Hill Book Company, Inc., New York, 1945; 389 pages, $2.20.

Intended to be used either as an engineering text or as supplementary study material, the book applies the mathematical theories that are generally confronted by the mechanical and electrical engineer in modern industry. The majority of the geometrical problems included were selected from thousands of examples that occurred in the engineering department of the Ford Motor Company. The authors have duplicated certain problems for the purpose of enabling the student to retain the principles involved. Although this text was written mainly for the mechanical engineer, the problems are also suitable for use by students in other branches of engineering.

A Teachers Manual for Science of Pre-Flight Aeronautics, edited by George Franklin Stover; The Macmillan Company, New York, 1945; 213 pages, $0.80.

One of the "Air-Age Education Series," the teachers' manual for preflight aeronautics is offered in revised form. The manual is intended to provide text and teaching materials for older students in high schools and pertinent materials that may be incorporated in the existing aviation courses in the curriculums of secondary schools.

Joint Aviation Users Conferences; National Aeronautic Association, Washington, D.C., 1945; 171 pages.

A brochure containing pertinent attendance data and a verbatim record of the addresses and proceedings at the business sessions of the First Joint Private Flying Conference, November 26–27, 1945, at Washington, D.C. The conference was held under the sponsorship of the National Aeronautic Association and was directed by the Joint Aviation Users' Conferences.

The Annual Temperature Cycle of Lake Michigan, Part II: Spring Warming and Summer Stationary Periods, 1942, by Phil E. Church; Miscellaneous Reports No. 18 of the Department of Meteorology of the University of Chicago, University of Chicago Press, Chicago, 1945; 100 pages, $1.50.

The second part of the report on the program of taking bathythermograph soundings on Lake Michigan deals with that portion of the data taken between March 21 and September 18, 1942. Between these two dates, the lake passed through two thermal periods, the spring warming period and the summer stationary period.

A detailed report is included about numerous cruises made by railroad-car ferries and other craft equipped with the necessary instruments for taking these temperature soundings in various parts of the lake, comparing the results with figures obtained at other locations and at different times. Extensive comments are made concerning conditions prevailing at the time of taking the soundings and concerning the causes of the changes noted.

The text matter is accompanied by numerous maps, charts, and tables recording the readings taken. The conclusions are summarized under the headings of vertical temperatures and horizontal temperatures.

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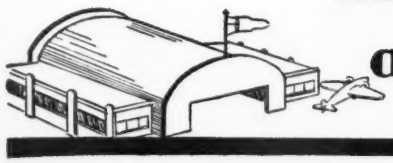
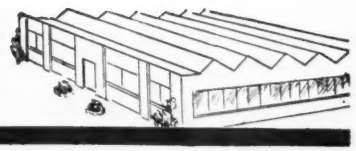




Instrument-Catalog Sheets

Aircraft-Instrument Data Sheets. Revised pages for the manufacturer's instrument catalogs contain data about the latest types of air-borne instruments. Section 20C, pages 1–4 and 9–11, describes current models of the attitude gyro, with specifications, drawings, and photographs. Section 29A, page 1, shows vacuum pumps and oil pumps; Section 29B, page 1, details the Venturi tube for operating gyroscopes; Section 29C, page 1, refers to the vacuum relief valve; and Section 29D, page 1, describes a central air filter. *Sperry Gyroscope Company, Inc.*

Review of an Aeronautical Manufacturer's Activities

A Pictorial Report by United Aircraft Corporation. Illustrated in color, a booklet contains a report on the accomplishments of the manufacturing divisions of the United Aircraft Corporation in resuming peacetime activities. Emphasis is placed on the continued importance of research and development to provide power and propulsion equipment for the new commercial aircraft being planned by the air lines and the air-frame manufacturers, as well as to improve the range, speed, and ruggedness of military aircraft for the armed forces. Brief descriptions are given of the new Pratt & Whitney Wasp Major engine, the latest Hamilton Standard propellers, Chance Vought airplanes, and Sikorsky helicopters. A table lists the commercial and military airplanes powered by Pratt & Whitney engines and equipped with Hamilton Standard propellers. *United Aircraft Corporation.*

Induction-Heating Data

Induction Heating. The scope and range of Budd induction-heating equipment are explained in a 24-page booklet illustrated in color. It defines the limitations with regard to the material that can be treated by induction heating, explains the types of heat-treating equipment, and illustrates the types of work produced by the manufacturer's induction-heating equipment. Detailed descriptions are given of the different models and the kinds of work they are intended to perform. *Budd Wheel Company, Induction Heating Division,* Detroit.

Swedish Contributions

A Swedish Light Aeroplane with a New Variable-Pitch Propeller. A single-seat sporting monoplane manufactured by Skandinaviska Aero Aktiebolaget of Norrtälje, Sweden, is described as an interesting development from that country. The airplane is a low-wing cantilever plane of stressed-skin wooden construction, fitted with a retractable landing gear and slotted flaps. Any one of three different types of engines (a 60-hp. Walter Mikron-4 Mk. II, a 92-hp. Cirrus Minor, or a 105-hp. Hirth HM 504A) can be installed without altering the engine mounting. Among the unusual features noted is the tail plane mounted half way up the fin, well above the fuselage; the rudder being split into two portions; and the Dynamatic variable-pitch propeller. Power for adjusting the pitch is supplied by a hydraulic pump actuated by the engine's lubricating oil under normal operating pressure. Detailed descriptions of the propeller and its operation are clarified by photographs and drawings. *The Intava World,* February, 1946.

Perspective-Drawing Machine

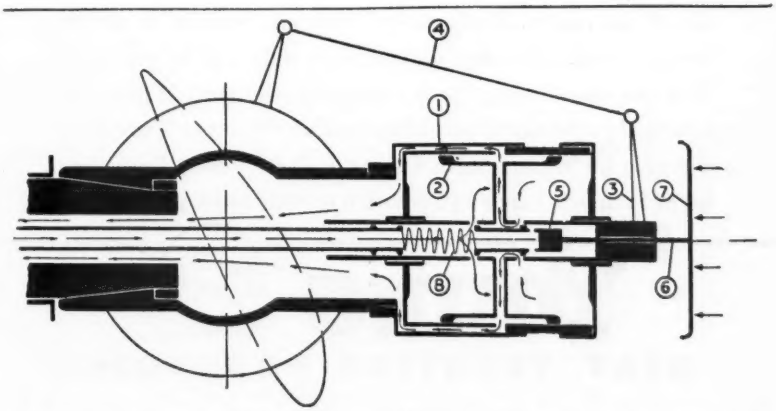
How to Operate the Pomeroy Stereograph. A 6-page folder describes the Pomeroy Stereograph Machine as a self-contained, perspective-drawing machine that permits the production of a stereoperspective pair of drawings that can be viewed as a synthetic reality in space. The leaflet explains the theory of direct-vision perspective, showing how the machine applies that theory. It gives detailed instructions for the operation of the machine. *Pomeroy Stereograph Company, Inc.,* Cleveland.

War Achievements of a British Aircraft Manufacturer

Record of Great Achievement in War. The contributions of the Fairey Aviation Company Ltd. toward the Allied war effort are reviewed in a report concerning the variety and scope of the company's work during the war. Particulars are given about the output of airplanes and propellers, the research and testing work done by the company's plants, and some of the secret projects on which the company was engaged. The prospects for continued important peacetime activities are viewed optimistically. *Fairey Affairs,* November, 1945.

Modern Structural Engineering

Structurally Speaking. W. E. Beall. The Vice-President in Charge of Engineering—Sales, Boeing Aircraft Company, relates the improvements being made in the structural design and construction of present and future large transport aircraft. He outlines the function of the structural engineer in research, development, testing, and analysis to provide the designer with the necessary data to achieve increasingly efficient structural design. He reviews the problems with which the structural engineer has to contend and indicates the fundamental principles to which the Boeing design organization adheres in its work of creating stronger and better airplane structures. *Boeing Magazine,* March, 1946.



A cutaway drawing of the Dynamatic variable-pitch propeller as used on the Swedish Skandinaviska Aero A.B. single-seat sporting monoplane. The principal components are (1) servo cylinder, (2) force piston, (3) lever, (4) rod, (5) regulator piston, (6) regulator piston rod, (7) air disc, and (8) regulator spring.

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British Air-Transport Operations

Air-line in Action is the title of an illustrated booklet that reviews the war history of the British Overseas Airways Corporation. Tracing the operations of the organization prior to the amalgamation of Imperial Airways and British Airways, it tells of the extent of the work of the predecessor companies in developing air routes throughout the British Empire. As soon as the war started the corporation became wholly engaged in the war effort, and figures are included showing the total mileage and tonnage flown, the number of passengers, and the extent of the corporation's personnel. Charts help to visualize these figures. The latter part of the booklet contains recitals of the company's operations in the individual war theaters, including the West African desert, the North Atlantic Ferry Service, campaigns around the Scandinavian countries, and the Mediterranean. The company's prospects for peacetime growth are estimated. *British Overseas Airways Corporation.*

Fire-Extinguishing Equipment

Air Foam is an illustrated booklet that outlines the development and use of the manufacturer's equipment and materials for extinguishing fires in inflammable liquids. It explains how the material is manufactured and used, how it performs its function of extinguishing fire, and its advantages for that purpose. *Pyrene Manufacturing Company,* Newark, N.J.

Aircraft-Ignition Cables

Harness for 1200 Horses. Howard M. Wilkoff. The design and construction of ignition harness for multicylinder internal-combustion aircraft engines are described. The part played by Vinylite plastics as an insulation material and protective coating for these cables is emphasized, with notes concerning the ability of the material to resist the effects of weather, greases, oils, and deicing fluids. *Bakelite Review,* April, 1946.

Air Freight

United Air Lines' Air Freight Service. In a pamphlet of 12 pages United Air Lines sets forth its facilities for transporting freight by air on a nation-wide basis. The pamphlet outlines the advantages of air freight service and suggests the types of products that can be shipped profitably. It gives a comparison of the costs of shipping, tells of the type of planes that will be used, and answers questions concerning the points reached by the service and matters of packaging and delivery. *United Air Lines.*

Uses for Small Switches

Bulletin No. 36 is a compilation of suggested applications for Micro Switch products in gaging devices and in automatic controls. The booklet is divided into four parts, the first showing the uses of the Micro Switch in gaging de-

vices and the second part indicating how these products are used in electrical controls. The third part describes the construction and operating principles of the switches, and the fourth part supplies precautionary comments concerning the applications of the switches for gaging, sorting, and control uses. *Micro Switch Division of First Industrial Corporation*, Freeport, Ill.

Synthetic Materials for Electrical Uses

Celanese Synthetics for Electrical Industry outlines the various Celanese synthetic materials in the form of plastics, textiles, and chemicals intended for use in electrical equipment. The characteristics of the materials, their mechanical and electrical properties, and some of their applications in the electrical field are described. The materials are listed according to their trade names—with descriptions, properties, and uses—in the form of text, tables, and charts. *Celanese Plastics Corporation, Division of Celanese Corporation of America*, New York.

Bearing-Testing Instrument

The Race Tester is a 4-page folder that describes an instrument for measuring the surface of antifriction bearing race ways. The instrument is designed for production use in race-grinding and finishing departments. The text discusses the functions performed by the instrument, how it operates, and the results accomplished by its use. *Physicists Research Company*, Ann Arbor, Mich.

Air-Transport Problems

A Review of Transportation Problems by the Airlines of United States. A leaflet of 8 pages gives, in question-and-answer form, a series of comments about the relationship of Government policies to the growth of air transportation. Among the requirements noted for continued expansion of air transportation are: the necessity for freedom from multiple state taxes and state barriers to air travel; the questions of integration and control of the air lines by companies engaged in older forms of transportation; and matters of Government regulation and finance. *Air Transport Association of America.*

Booklets About Transportation

National Transportation Policy is a report prepared for the annual meeting of the Chamber of Commerce of the United States of America. It outlines the current condition of the transport industry as a whole following the termination of the war and suggests policies for adoption by the Chamber with regard to its recommendations for improvements in the various industries concerned with transportation. Although the report deals largely with the railroads, other means of transportation are given consideration, including air transport.

International Transport. A similar booklet sets forth recommendations for a policy concerning international transportation with regard to the re-establishment and expansion of America's international sea and air transport services. *Transportation and Communication Department, Chamber of Commerce of the U.S.A.*, Washington, D.C.

The Bell Model 42 five-place helicopter in flight. Its announced gross weight is 4,891 lbs. including a normal useful load of 1,435 lbs. The craft is powered by a 450-hp. engine.

Response to Inquiry About Air Passenger Travel

You Told Us What You Wanted in Your $500,000 Post-War Mainliner. A booklet gives a summary of the answers provided by 19,000 prospective air passengers to an inquiry requesting opinions about aspects of future air travel. The booklet summarizes the wishes of the people who answered this questionnaire, showing their preferences with regard to seating accommodations, interior decoration of the airplane, sleeping facilities, baggage, flight personnel, transportation to and from airports, meal service in flight, and other facilities suggested for the comfort and convenience of air passengers. *United Air Lines.*

Cable Connections for Electric Welding

Tweco Products are described and illustrated in a 9-page catalog. The products are used in making cable connections for electric welding and consist of the manufacturer's "Twecotong" electrode holders, clamps, terminals, cable connections, lugs, cable splicers, and miscellaneous equipment. *Tweco Products Company*, Wichita, Kan.

War Services of a Light-Plane Manufacturer

The War Years at Piper Aircraft. Wilbur L. Hower. How the facilities of a large manufacturer of small personal airplanes were utilized in the war is revealed in a review of the contributions of Piper Aircraft Corporation. It is noted that, in addition to the production of the Army "Grasshopper," designated as the 0-59 two-place observation plane and later listed as the L-4 liaison plane, the company produced secret radar equipment, ambulance planes, and what was called the "Glomb" glider bomb, as well as training gliders and other products. *The Cub Flier*, March-April, 1946.

Control Equipment Actuators

Lear Friction Drive Servo Actuators is the title of Booklet A-202-1. It contains descriptions of various models of servo actuators. The Lear servo actuator is, in effect, an electromagnetic friction drive consisting of two continuously driven, conical electromagnets, geared together so as to rotate at the same speed but in opposite directions. The features of the mechanism are included, as well as the principles upon which it operates and applications for which it is suited. Drawings show the dimensions of the units, and charts give figures on their performance. *Lear, Inc.*, Grand Rapids, Mich.

Laboratory Facilities

Cornell Aeronautical Laboratory—Its Role in Education and Research. The facilities of the Cornell Aeronautical Laboratory, which was given to Cornell University by Curtiss-Wright Corporation, are outlined in text and pictures in a booklet of 10 pages. It describes the achievements in research to which the laboratory contributed and its functions in connection with the Graduate School of Aeronautical Engineering. *Cornell University.*

Safety Tool Catalog

Ampco Non-Sparking Safety Tools lists more than 500 items in a group of tools made of Ampco Metal and beryllium copper. Such tools are designed for use in the presence of explosive liquids, fumes, gases, or dust for the prevention of fires and explosions that might be caused by sparks from steel tools. The tools are listed alphabetically, ranging from adzes to wrenches of various types. *Catalog No. 117, Ampco Metal, Inc.*, Milwaukee.

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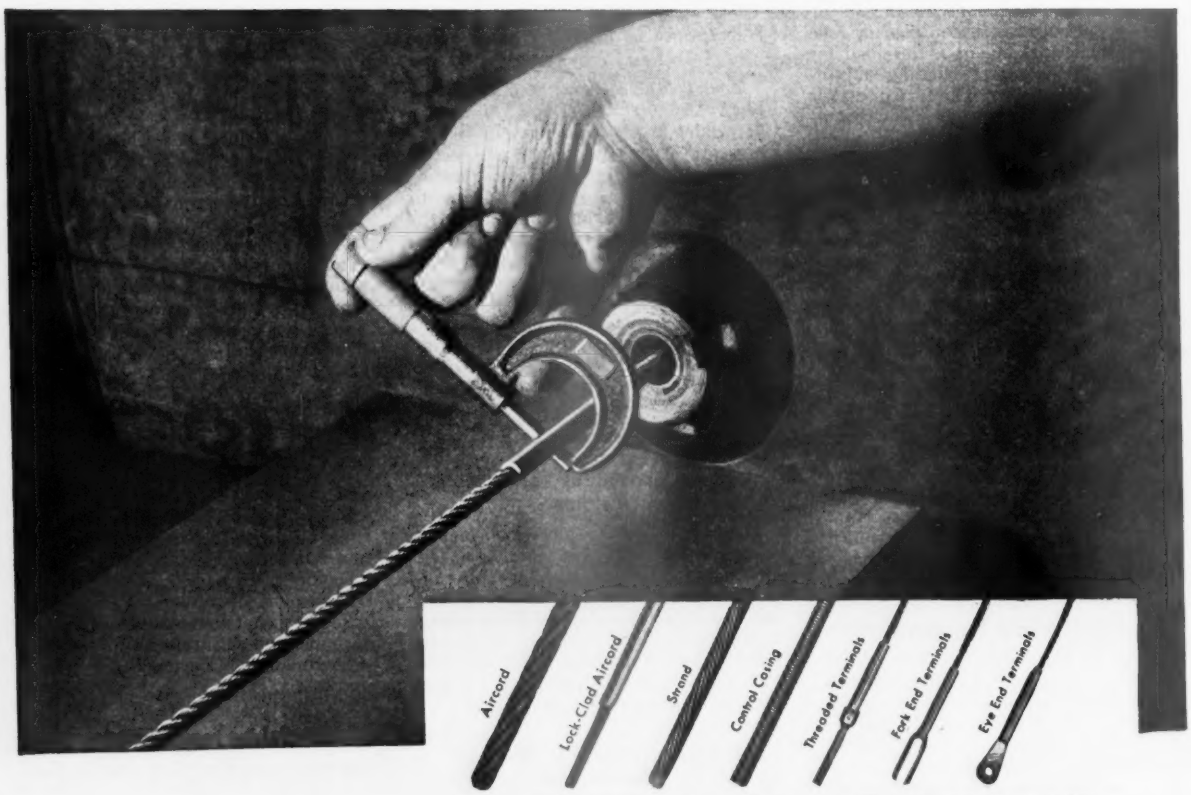

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Photoelastic Stress Analysis is an 8-page folder that gives background information and basic working specifications for the technique of stress analysis by photographic means. It contains a compact but comprehensive survey of the general photographic aspects of photoelastic stress analysis and deals briefly with such subjects as the optical theory involved, the apparatus used, photographic materials, analysis of the records obtained, and three-dimensional analysis. *Eastman Kodak Company.*

Air Traffic-Control Systems

Aerial Navigation and Traffic Control is the title of *Technical Memorandum No. 155.* It comprises a fabric-bound booklet detailing four systems of air navigation and control of traffic designated by the names Navaglobe, Navar, Navaglide, and Navascreen. The booklet is divided into four sections, each describing one of the four systems. The sections are further designated as (1) the Navaglobe system of long-range navigation over oceans and continents; (2) Navar for traffic control around airports; (3) Navaglide for instrument landing and automatic landing; and (4) Navascreen for displaying and computing traffic-control data. The text explains in detail the theory and practice involved in each system, illustrated by drawings and photographs. *Federal Telecommunication Laboratories, Inc., an Associate of International Telephone & Telegraph Corporation.*

Instruments for Private Airplanes

New Scout Instruments by Kollsman is an 8-page descriptive folder showing a new group of instruments developed for private planes. In addition to actual-size illustrations of the various instruments, a short description is given of each, together with complete specifications and prices. The AN standard panel cutout dimensions for the various units are also shown. The instruments include standard and sensitive altimeters, air-speed indicators, compasses, climb indicators, manifold-pressure gages, tachometers, direction indicators, and clocks. *Kollsman Instrument Division of the Square D Company.*

Testing Machines

Olsen Universal Testing Machines. Bulletin No. 30 is a new catalog dealing with the manufacturer's entire line of Universal testing machines for tension, compression, and flexure testing. Included in its 56 pages are detailed descriptions of the principles of operation of the Olsen pendulum-lever weighing system, hydraulic and electromechanical loading systems, testing ranges, and detailed specifications on machines rated from 1,000 to 1,000,000 lbs. or more.

Other sections describe the manufacturer's "L"-type and Lo-Cap testing machines, as well as electronic high-magnification recorders, proofing rings, and accessories and tools. Tables give dimensions, specifications, and other data, and numerous illustrations show the various machines and the equipment used with them. *Tinius Olsen Testing Machine Company,* Philadelphia.

Explanation of Swaging Operation

Commentary of Motion Picture "Swaging" is the title of a booklet in which is reproduced the commentary accompanying the motion picture produced by Bray Studios, Inc., to explain the process of swaging. It defines the methods, explains the advantages, and tells about the applications of swaging as a manufacturing process. It contains illustrations and complete descriptions of the machinery used for swaging and a table showing the production rates of various types of swaging machines. *Standard Machinery Company,* Providence, R.I.

Hydraulic Accumulators

Accumulators for Industry. An illustrated folder outlines the advantages of power transmission by fluid under pressure. It explains the construction and uses of the hydraulic accumulator, which is manufactured in types designated as the gravity type, the spring-loaded type, the air-loaded piston type, the diaphragm type, and the enclosed-bladder type. Sketches show the construction of these types, and graphs designate their performance characteristics. *Greer Hydraulics, Inc.,* Brooklyn, N.Y.

Air Line's Progress

Parade of Progress is an 8-page leaflet in which the achievements of Pan American World Airways from 1927 to the present are recorded. Mention is made of the research and development work carried on by the company in conjunction with the aircraft manufacturers, and the services rendered by the company's airplanes are reviewed. A tabulation shows the numbers and types of airplanes used by the company between 1932 and 1945. *Pan American World Airways, Inc., Pacific-Alaska Division.*

Soundproofing Large Airplanes

Keeping It Quiet. Wellwood Beall. The Vice-President in Charge of Engineering—Sales, Boeing Aircraft Company, writes about the problems of isolating flight noises in large airplanes such as the B-29, the C-97, and the Stratocruiser.

He defines the twofold considerations as (1) the isolation of external noise and (2) the minimizing of noise produced internally for which the remedies are the installation of good soundproofing material and the proper placing and shock mounting of noise-producing equipment. Spun-glass batting was found satisfactory as an insulating material, with added advantages of resisting mildew and tropical fungi. A possible future development involves a fuselage constructed of one shell within another, with a partial vacuum created in the intervening space by evacuating the air, since sound does not readily traverse a vacuum. However, structural problems would have to be overcome. *Boeing Magazine,* April, 1946.

Electrical Insulation Material

GE Mycalex is the title of a catalog describing a stonelike product composed of ground mica and a special glass which can be molded to the desired shapes with or without metal inserts by either the compression or induction-molding process. Tables give details concerning the properties of the material, and the text describes the uses for which it is suitable. The various features of the materials—such as dielectric qualities, arc and heat resistance, mechanical strength, water absorption, moldability, and machinability—are compared with the same properties of cold-molded refractory materials, hot-molded phenolics, wet-process porcelain, steatite, and fused quartz.

The design section of the booklet explains the size range, thicknesses, undercuts, taper, radiuses, holes, and inserts that are practicable in molding Mycalex parts; preferred shapes, tapped holes, counterboring, thickness of flat parts, round rods, corners, angles, holes, bushings, slotted bars, and tolerances of fabricated parts; and cutting, drilling, tapping holes, punching, milling, and grinding of machined parts. *General Electric Company.*

Applications of Electronics

The Businessman's Guide to Electronics. An extensively illustrated booklet discusses in nontechnical language the services that can be performed by electronic equipment. A chart gives a simple explanation of the six fundamental functions of the electronic tubes, and the different sections of the booklet illustrate the processes and uses of electronic induction heating; dielectric heating; welding; control and regulation; power conversion; production; sorting, counting, and weighing; inspection; and measurement and analysis. *Westinghouse Electric Corporation.*

Engine Stress Analysis

Putting the Stress on Engines. Robert M. Platz. The work of the Stress Laboratory of the Ranger Aircraft Engines Division of Fairchild Engine & Airplane Corporation is reviewed in nontechnical language. The writer explains the use of the electric strain gage and other testing instruments, including equipment for photoelastic analysis. In addition to the testing instruments, the laboratory is equipped with devices for applying loads required for the test, and brief comments are made concerning that type of equipment. *The Pegasus,* May, 1946.

MOLYBDIC OXIDE—BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"
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From the Industry

Loading Stand for Large Transports

New ramps of circular form are designed specifically for the larger transports, such as the DC-4 and DC-6. The circular loader has two stairways that rise in opposite directions and connect by means of a semicircular platform. Use of the two stair flights is intended to add to passenger safety during the loading and unloading operations, and permits compact construction of the ramp. A rise of 90 in. to the top loading platform is permitted, with overall dimensions of 85 in. wide and 126 in. long retained.

The entire stand is constructed and stressed to accommodate considerably more than maximum passenger loads. This is primarily aimed at providing a durability margin that will ensure the ramp's ability to withstand side stresses resulting from collision with ground objects. Tubular steel for the primary structural supports is $1^1/_2$-in. outside diameter by 0.065-in. wall thickness. For secondary supports, 1-in. outside diameter by 0.065 and 0.035-in. is used. The rise of the steps is $7^1/_2$ in. and the tread is 10 in.

Weight of the ramp is kept to about 700 lbs. Two 16-in. tires, with wheels mounted on fixed axles, in combination with two 8-in. tires, with wheels on swivel casters, render the loader extremely mobile. On concrete or hard dirt surfaces, one man can move the stand and position it for use beside the airplane with comparative ease. The braking system for locking the stand in position is hydraulic. Actuated by hand lever, it accomplishes the lowering of the locking device, and shifts the weight of the loader to two pads that come into contact with the ground to provide a positive lock.

For night loading, the circular ramps are equipped with lighting systems, for which current is supplied by the airplane's batteries. Dome-type lights are used on each stair. Provision has been made, through the use of a gate and extension of the top platform, so that a fork lift may be used for loading food and incidentals without obstructing the use of the stairway. On airplanes with doors that open outwards, the gate permits the door to be opened after the ramp is positioned beside the plane and then holds the door open during loading. Aircraft Mechanics, Inc., Colorado Springs, Colo.

Gas-Turbine Tests

What is said to be the first large stationary gas turbine to generate power with a gas temperature as high as 1,350°F. is undergoing tests at the Naval Engineering Experiment Station at Annapolis, Md. Operating under progressively increasing gas temperatures, the experimental gas turbine will be run at an eventual maximum of 1,500°F.

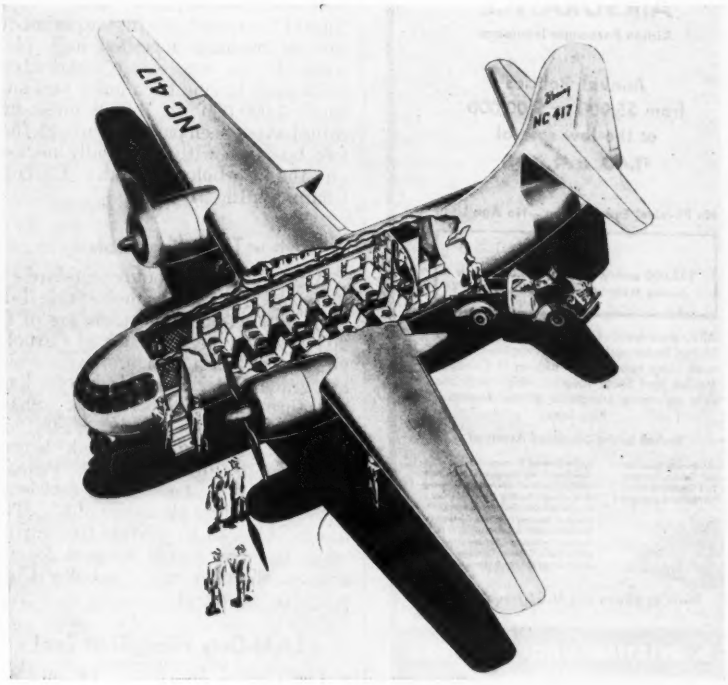
So detailed was the instrumentation testing of this model that 2,000 different readings of temperature and pressure throughout the gas turbine were recorded during a 7-hour test period. Numerous mechanical, metallurgical, and fluid-flow problems prominent in gas-turbine development have been overcome in testing the unit, which embodies innovations in cooling methods permitting the multistage turbines to operate safely at high inlet temperature. Allis-Chalmers Manufacturing Company, Milwaukee.

Releases are printed as received from companies and other aeronautical organizations and the responsibility for the accuracy of all statements is therefore not assumed by the Aeronautical Engineering Review.

Twin-Engined Airplane for Local Air-Line Service

The Boeing 417, a smaller version of the 80-passenger Stratocruiser, is a twin-engined, high-wing transport seating 20 to 24 passengers, and powered by 800-hp. Wright Cyclone engines. It was designed to make accessible to local service and feeder air lines the advantages of the advanced engineering available to the large-airplane field in such planes as the Stratocruiser, the Flying Fortress, and the Superfortress.

Decision to produce the 417 was reached after an extensive survey into the smaller transport field. The survey revealed that, while the postwar emphasis has been chiefly on the development of aerial supertransports of the transcontinental and ocean-spanning types, there is a definite need for a modern, comfortable airplane with low operating cost, which can carry the average passenger



The Boeing Model 417.

on short-range intercity trips or connect with trunk-line flights.

The newest Boeing has a wing span of more than 86 ft. and is approximately 60 ft. long. Features of the plane include thermal anti-icing of wing and tail surfaces; wide-tread, dual-wheel tricycle landing gear and steerable nose wheel; low step-contained entrance doors to eliminate ramps and other ground handling equipment; provision for installation of cabin altitude conditioning; an independent system for cabin heating and ventilating on the ground as well as in the air. Easily removable, interchangeable power plants, and a roomy, wide-vision flight-control cabin with accessible flight and engine-control systems are other features. Boeing Aircraft Company.

Adjustable Circle Cutters

The Bruno adjustable circle cutter cuts smooth, large-sized holes in wood, steel, brass, hard rubber, aluminum, fiber, plastics, and other materials. It cuts holes to any diameter from $1^7/_8$ in. to 8 in., through $^1/_4$ in. thickness in steel or other tough metals, and any thickness up to $1^1/_2$ in. in plastics, fiber, or wood. Thickness capacities may be doubled if the cut is made in both sides of the material. The tools are designed to operate in any standard drill press, woodworking machine, or suitably mounted spindle machine.

The cutter consists of a combination drill and pilot with a new, improved, high-speed cutting blade, adjustable to depth and diameter. The exclusive "Wedgelok" cutting-blade holder permits the cutting edge to recede or yield from work while still maintaining steady pressure and feed. The cutting blade is easily resharpened without special tools, by grinding on one edge only. The twin-blade holder having a fixed $^1/_2$-in. center, cuts washers, wheels, discs, and gaskets in one operation. Bruno Tools, Beverly Hills, Calif.

Cemented Carbide Bushings for Aircraft Towing Cables

Utilization of small Carboloy cemented carbide bushings as guides for aircraft target-towing cables not only saved the U.S. Navy thousands of dollars in launching cables and eliminated an indeterminate loss of time and materials in the target-practice operation, but also probably saved lives of Navy personnel, according to a report from the Naval Air Station, Norfolk, Va.

When launching a target from the towing plane, as much as 7,000 ft. of $^1/_8$-in., 7-strand by 19 stainless-steel wire cable is paid out at high speed. The cable runs through two bushings in outrigger tubes, each bushing having a hole approximately $^3/_8$ in. in diameter. Complete failure by wearing out of bushings had occurred in some instances on even the first or second launching of the target, resulting in loss of the stainless-steel cable, which alone is worth about $300. In addition to the loss of time and material, fouling of the target created a serious danger to personnel.

Towing-cable guide bushings of Carboloy metal were tried and quickly adopted as standard. Reports state that the carbide bushings were found to resist wear 100 times as well as the best bushings previously used. At the time of the report, the first experimental carbide bushings installed in a plane were still in use, many hundreds of launchings having been made and more than 3,000,000 ft. of stainless-steel cable having been paid out through these two bushings with practically no wear on the Carboloy metal. Carboloy Company, Inc., Detroit.

Threading Tools

A new line of Carboloy standard carbide-tipped threading tools, Style T-15, is in production. The tools are of the 60° V-nose type with tips of Carboloy Grade 78-B, a tough and wear-resistant grade of carbide, suitable for long-run threading of steel parts. Shank sizes include $^3/_8$-in., $^1/_2$-in., $^5/_8$-in., and $^3/_4$-in. square styles. Shank lengths run from $2^1/_2$ in. to $4^1/_2$ in. Primary clearance at the nose of the tool is 3°, with a secondary clearance of 6°. This design is stated to provide free cutting while insuring ample support for the nose of the tool tip. Carboloy Company, Inc., Detroit.

Light-Duty Blind-Rivet Tool

The Cherry Jr. riveter, an inexpensive, light-duty blind-rivet tool, is a one-hand, plierlike tool that installs the rivet with a simple pull. It is made especially for the many small fastening jobs arising constantly in any shop. It installs a new $^3/_{32}$-in.-diameter blind rivet. The rivet is the tight-clinching, pull-through hollow type, available in three grip lengths and having adequate shank expansion. Cherry Rivet Company, Los Angeles.

Electronic Frequency Meter and Tachometer

The CML Model 1800 A-F frequency meter and tachometer is a device for measuring the frequency of a.c. voltages over the entire audible frequency spectrum. In conjunction with a new "photo-to-beam converter," Model 1800 instantly becomes an accurate electronic tachometer for measuring the speed of rotating or reciprocating mechanisms, including those which cannot be subjected to any additional mechanical load.

One of the novel features is that it can measure the frequency of positive or negative "radar-type" pulses from a fraction of a microsecond to more than 50 microseconds in duration. A separate input jack is provided for pulse operation. The wave input circuit will accept voltages of practically any wave form having a duration of from 50 microseconds to 100,000 microseconds (20,000 to 10 cycles per sec.). Thus, inasmuch as the two ranges overlap, the operation can be said to be independent of wave form.

The accuracy of Model 1800, because of its adequate regulation of all critical

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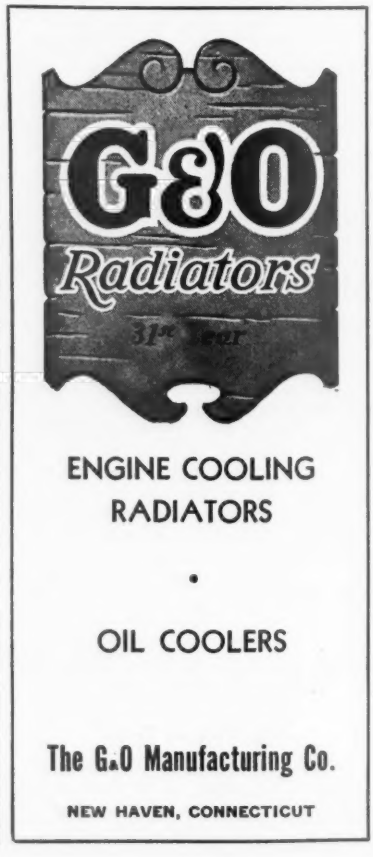


circuit and tube parameters, is affected to the extent of only 0.1 to 0.2 per cent by line-voltage variations of 105 to 125 volts, by temperature variations from 0° to 70°C., or by high relative humidity. As a tachometer, the Model 1800 frequency meter, in conjunction with two Model 1900 photo-beam converters, can be used in the study of gear mesh, torque, and dynamic strain, as indicated by the relative difference in the speed of two rotating shafts. The outputs of the two photo-beam converters can be mixed electrically so that the instantaneous speed difference between the two rotating shafts will be continuously recorded on the frequency meter, provided that the difference is in the order of 60 r.p.m. or greater.

Vibration rates can be accurately measured by the application of a suitable pickup device to any stationary object subject to vibration. Sounds detected by microphones or phonograph pickups can be readily checked for frequency or pitch. Communication Measurements Laboratory, New York.

Tension Measurement Instrument

The Dillon Tens-O-Trol electric remote tension and weight indicator is a combination of the Dillon dynamometer and responsive self-synchronous motors. It is not necessary for the operator to be close enough to the measuring instrument to read it, because the system incorporates remote repeater stations that may be as far as 300 ft. from the actual measuring dynamometer. The repeater stations measure 12 in. wide by 14 in. tall and are 5 in. in depth. The dial itself is $9\frac{1}{2}$ in. in diameter and is made of lacquered brass with etched numerals 1 in. high. It is recessed and brightly lighted around the edge where conditions of normal illumination are poor.

The master indicating motor is mounted to the dynamometer boom in such a manner that the slightest amount of tension or weight unbalances its field. This electrical excitation is transmitted by cable to the repeater stations where the field of the receiving motor is correspondingly unbalanced. In that way, whatever the master transmitter deflects is duplicated at the repeater stations with a limit of inaccuracy of less than $1\frac{1}{2}$ per cent.

In aircraft work, the instrument indicates tension in glider-tow ropes and structural loads while in actual flight. The master transmitter may be connected in series with loads and read remotely by engineers in the test cabin. It is suitable also for wind-tunnel testing, as the operator can read the indications of a stress in the control room and at a distance from the device being tested. W. C. Dillon & Company, Inc., Chicago.

Dumore High-Speed Bench Drill

A lightweight, high-speed bench drill for $\frac{1}{8}$-in. drills and smaller is designed particularly for use in the fabrication of small parts of metal, wood, or plastic items and equipment. The drill head is firmly held in the desired position on the polished solid-steel column with a locking device. It rigidly holds the motor in place, yet permits vertical adjustments and a 360° radius of action. The table is mounted in like manner.

The drilling operation is accomplished by elevating the table to the drill through the use of a hand control geared to the table. This feature is an advantage in getting the proper work-feeding speed. Power is supplied by a $\frac{1}{30}$-hp. motor with a range of 2,000 to 15,000 r.p.m. The speed is controlled by a foot rheostat, permitting free use of both hands for the drilling operation. The drill weighs 15 lbs., making it suitable for portable or bench use. The Dumore Company, Racine, Wis.

Luminescent Plastic Sheeting

New forms of Lucite acrylic resin containing luminescent pigments—a fluorescent type that glows when exposed to ultraviolet light and a phosphorescent type that glows in the dark after exposure to ordinary light, now are being produced for airfield markers and other applications.

Sheets of Lucite containing luminescent pigments called "phosphors" also are being produced on a small scale. After exposure to light, the sheeting gives light of maximum brilliance for a matter of minutes, and then continues for 10 to 12 hours to give light sufficient to be seen by an eye adapted to the dark. The fluorescent sheet does not necessarily "store" light, but glows brilliantly while subjected to ultraviolet light, commonly called "black" light.

The sheets can be manufactured in a wide range of colors, in all of the standard sizes, and in various thicknesses. E. I. du Pont de Nemours & Company.

Transparent Enclosures

A special ultraviolet light-absorbing type of Lucite acrylic resin that is stated to give protection from sunburn to fliers has been developed for use on war planes and is said to have been specified for the windshields and enclosures on several light planes.

The new material is being manufactured in clear and in green transparent sheets, the latter offering antiglare properties in addition to filtering out the harmful portion of ultraviolet light. It is stated that the green transparent sheeting was used for enclosures on the B-25 bomber and the CG-4 glider during the latter part of the war. E. I. du Pont de Nemours & Company.

Translucent Papers to Speed Industrial Copy and Blueprint Work

Three industrial photographic papers that will speed the production of paper positives from engineering drawings and enable unusually high-quality blueprints to be produced, are known as Reflex Copy TXA, Linagraph Ortho TXA, and Linagraph Blue Sensitive TXA. The new papers are translucent, of extra light weight, and have an extremely high wet and dry strength. As a result, they can be used for filing purposes or for binding into a book of drawings or printed matter.

Because of their extra lightweight base and high degree of translucence, these papers may be used in place of film negatives where rapid printing time in making subsequent positives is necessary. They can also be used in any branch of industrial copy work where prints of minimum weight and thickness are important.

Reflex Copy Grade TXA paper will be supplied in the same sizes and at the same prices as Reflex Copy Grade A and Grade XA papers. Linagraph Ortho Grade TXA and Linagraph Blue Sensitive Grade TXA papers will be supplied in the same sizes and at the same prices as Linagraph Ortho Grade A and Grade XA papers. Eastman Kodak Company.

Engine Starter-Generator

A new Eemco direct-drive, lightweight, combination starter-generator unit for aircraft engines and other engine applications, has been under development and is about to be put in production. It is stated that the production model designed for use on small aircraft has been refined even further than the original starter-generator as a result of thorough testing by the manufacturer and a number of engine builders. The weight has been pared down to 17 lbs., compared with the usual total weight of 30 to 35 lbs.

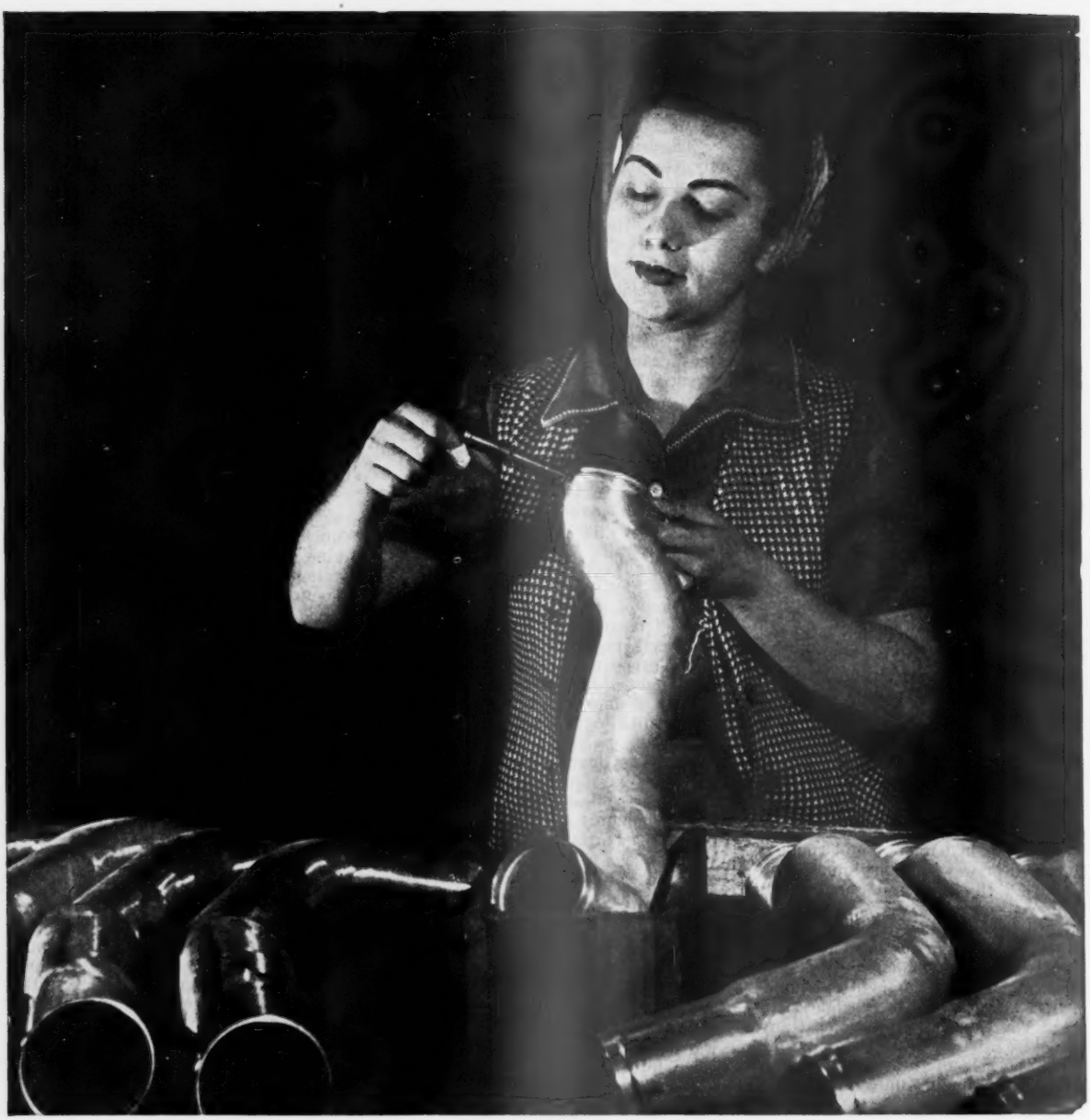
Another refinement is the reduction of overall length to $9\frac{1}{2}$ in., to allow greater clearance between the starter-generator and the engine fire wall. The output of the generator, 35 amp. at 14 volts, permits full use of radio and other electric accessories with only a small storage battery.

Tests were conducted with the starter-generator on a well-known make of four-cylinder 75-hp. aircraft engine equipped with impulse magnetos. It is stated that the starter-generator was able to start the engine on 4 volts, and that this indicates the unit can be used consistently and successfully with a small battery of limited capacity. Other tests indicated that the starter-generator torque-limiting system could successfully cope with abnormal firing conditions.

The starter and generator are combined in one unit, the same windings serving for both. The starter gear reduction for cranking is 23 to 1; the generator reduction is $2\frac{1}{2}$ to 1. Maximum starting torque is 160 ft.lbs. Generator output is 500 watts, continuous duty. The torque-limiting clutch, built into the unit, prevents damage to the unit from backfire. The coupling to the engine crankshaft eliminates the need for belt or chain drives. Adapter mounting brackets are provided for the popular makes of engines. Electrical Engineering and Manufacturing Corporation, Los Angeles.

Instrument-Panel Light

After extensive wartime application in aircraft, the Fairchild Camera &



A micrometer must say "Okay"!

"Check" and "double-check" is the rule at the American Tube Bending Co., Inc. The micrometer and other measuring instruments must say, "Okay", before a tube can pass through the numerous processes along OUR production line.

For instance an aluminum tube is subject to distortion in handling, since it must be in an annealed state on part of its journey through our plant. Therefore, a micrometer is used to check the rounding of beaded ends.

All along the line it's a PRECISION job!

If you want this kind of careful tube-bending in manufacturing your product—intrust it to US.

Write for informative booklet, "Precision in Tube Bending". American Tube Bending Co., Inc., B1 Lawrence St., New Haven 11, Conn.

AMERICAN TUBE BENDING COMPANY, INC.

PRECISION to aircraft standards

Instrument Corporation's Moonglo light, an inexpensive instrument illuminator, has been redesigned and is again available commercially. It is a small cylindric device about the size of a key-ring flashlight, operated from the airplane's electrical supply. It measures only $1^1/_8$ in. in diameter and $3^1/_2$ in. in length, and weighs 5 oz. To give selective instrument-panel lighting, it projects a beam of soft, even light that provides illumination for complete instrument panels in the pilot's compartment, or small panels and individual instruments at the navigator's or radio operator's stations. It is used also to light radio-instrument panels at the side of the cockpit, and is good for map reading.

Its light intensity can be regulated by turning a large knurled ring at its forward end. This ring actuates a diaphragm, reducing the light intensity evenly over the entire area covered by the beam, but it does not affect the size or shape of the beam or alter its color value. Because of its even quality, the light does not produce reflections in the windshield or side windows. Since the usual method of mounting the illuminator is above the pilot's head at the centerline of the airplane, the beam is directed downward, and all reflections from the glass faces of the instruments and the smooth surfaces of the instrument panel go toward the floor.

A mounting lug provided on the illuminator permits easy attachment to the airplane structure by means of a Fokker-type tube clamp or any simple bracket. No special tools are required and the illuminator is so small that a neat, unobtrusive installation can be made in any desired spot. Fairchild Camera & Instrument Corporation.

Tool Bit with Shearing Action

The Shearcutter tool bit is claimed to make cuts two to three times its nominal size and to reduce production time and costs in the metalworking industry. Utilizing the principle of molecular cleavage, the new invention is stated actually to cut metal with a knifelike action instead of chiseling it off by the common metal-rupturing method. Standard in size, the tool embodies a scientifically presharpened cutting edge and chip-pressure channel to ensure true shearcutting.

Digging in and chattering action is prevented by the new method in which the tool uses the chip removed in cutting. This action of the tool tends to keep the cutting edge sharp. The shearing action makes possible cut depths up to three times the nominal size of the tool bit used.

Precision tolerances may be held with the Shearcutter bits and finishing cuts may often be eliminated. The cutting tool may be used on copper, brass, bronze, plastics, cast iron, steel, and other ferrous and nonferrous alloys without changing the original grind. Fearless Tool Company, Los Angeles.

"Packaged" Landing Gear

A package-unit undercarriage with a lightweight, efficient, and trouble-free shock absorption unit is being made available for all aircraft weighing less than 3,000 lbs. A nontechnical description states that a springlike rubber cylinder, filled with compressed air, cushions the initial impact of landing. Rings of friction material then act as brakes in restricting any bouncing tendencies. In the landing gear, there are no telescoping tubes, no oil valves or compartments, and no packing glands. Dust and dirt have no effect on the operation of the SuperFlex unit.

Without hydraulic fluid, the simplicity of the SuperFlex undercarriage and its lightness have enabled manufacturers to save weight, not only in the undercarriage, but also in the fuselage and wing structures that support the landing-gear assembly. It is stated that the device meets all C.A.A. requirements for overloaded landing impacts, it cannot stick or jam during compression or extension, and it has a minimum drag surface.

The SuperFlex undercarriage unit includes the landing gear, the tire, wheel, and brake. It can be installed easily and replaced quickly. Made in three sizes, it can fit practically any airplane weighing less than 3,000 lbs. The same principle of allowing the landing load to be absorbed by rubber displacement and air compression resulting from the upward movement of the wheel is being applied to larger aircraft. With the recoil positively controlled by the special-purpose friction material, taxiing over rough airfields is reported to become smooth. Firestone Tire & Rubber Company.

Aircraft Brakes

A new aircraft brake, with a "built-in cooling system," developed by the Firestone Tire & Rubber Company, is stated to have overcome excessive temperature build-up and its resulting complications of rapid wear, distortion of brake parts, leakage of hydraulic lines and fittings, and tire and tube deterioration. Development plans include application of the new design to brakes of 100,000 to 4,000,000 ft.lbs. kinetic-energy capacity. Such brakes would be suitable for small private planes and large bombers and transports.

Extremely low operating temperatures are stated to be made possible by using fabricated stator discs having as a friction surface, a thin sheet of high-conductivity copper backed by a disc of light aluminum alloy with extra heat-storage capacity. The low resistance to heat travel causes a flat heat gradient inducing subnormal temperature on the friction surface and much higher than normal temperature on the outer radiating surface. This results in a much higher overall rate of heat dissipation from the brake. The storage capacity takes the peak temperatures out of sudden, excessive brake applications.

Structurally, the brake is of a simplified design and is classified as a conventional, single-disc brake. A magnesium casting containing the hydraulic annular piston unit also acts as the base for all the major parts of the brake and is anchored to the airplane torque flange. On this casting, between the piston and the back thrust plate, a disc is mounted which is free to move laterally but fixed with the casting against rotation. Between the stator disc and back thrust plate is a disc of molded brake lining with lugs on its outer circumference which engage with notches in the wheel causing it to rotate with the wheel. When the hydraulic pressure is applied, this rotating lining disc is squeezed between the fabricated stator disc and back thrust plate to develop frictional brake torque. When the hydraulic pressure is released, release springs, which are built into the assembly, force the stator disc and back thrust plate apart, permitting a free, rotating lining disc without drag.

The new brake is reported to operate with low hydraulic pressures and to respond to pedal pressure promptly, smoothly, and quietly. Low operating temperatures make replacement of rubber seals infrequent and lead to a low rate of wear on all friction surfaces. The manufacturer states that the lining wear is never extensive enough to require adjustment except as such wear is absorbed in pedal movement. Firestone Tire & Rubber Company.

Piston-Travel Measurement

Precision engine timing by direct measurement of piston travel is provided by the new Model B Time-Rite designed for timing operations on all reciprocating-type aircraft engines. The features of the design—a slide pointer, automatically referenced, and an adjustable calibrated scale—eliminate the need for finding top dead center and compensate for the variables involved in accurate positioning. In addition to location of timing positions, either before or after top dead center, the instrument may be used for magnetic-point synchronization.

The construction of the device makes it equally valuable for shop or field use. The complete indicator kit includes carrying case, supplemental battery supply, battery leads, magneto-synchronizing leads, and instruction book. Calibrated scales are available for all types of engines, and all scale calibrations are obtained in cooperation with, and are approved by, the engine manufacturer. Gabb Manufacturing Company, East Hartford, Conn.

Welding Techniques Used in I-40 Gas Turbine

Utilization of many specialized types of welding to produce joints of great strength in lightweight metal was one of the main factors in the successful development of the General Electric Type I-40 jet-propulsion gas turbine. One of the chief features of the all-welded construction, besides the light-

weight metals used, is the horsepower-weight ratio of better than 2 hp. per lb. There are more than 500 welded joints in the engine, and in making them practically every known type of welding was utilized, each one in applications where its particular advantages could be best employed. For example, the circular seam welding of a flange to the outer exhaust cone is done by resistance seam welding, and many parts in the exhaust unit assembly itself, where pressure-tight welds are not required, are spot welded.

Heat-resistant alloys are required for the combustion chamber and the exhaust unit. In order to keep the weight of the engine down, these alloys were used in sheet form, some as light as 0.022 in. in thickness, giving high strength and good corrosion resistance at high temperature. By welding these parts the engineers were able to design for minimum weight with maximum joint efficiency, both in thermal strength and physical strength.

The fabrication included joint design, fixturing, welding process, and machining procedure. In considering joint design, it was first necessary to design for strength, then weight, distortion, and gas flow were closely checked. Where it was necessary to join pieces of different thickness, it was known that minimum weight would be obtained by using a straight butt joint. A joint of this type, however, would set up a stress concentration in the thinner piece and encourage failure in service. Fusion welding of this joint would also cause greater distortion. Therefore, where the flanges were welded to the exhaust casing or the ring holders, as well as to the flame tubes, a lap joint was used and the weld was generally made by resistance seam welding. This joint proved tight, had excellent strength, a minimum of distortion, and a neat appearance.

In cases where there was great variation in thickness, it was possible that fatigue failure would occur in the thinner section, next to the lap. Because of this, it was desirable to keep both pieces as nearly alike in thickness as possible. The longitudinal seams, in some instances, were designed for a flush joint without the necessity of grinding. These were made by clamping the joint in a fixture and backing it with hydrogen, and then welding it by the atomic-hydrogen process. The hydrogen backing was provided by burning hydrogen in a groove milled in the backing bar of the fixture. On the thicknesses up to $1/16$ in., it proved to be possible to butt the edges up square and, using the fixture as mentioned, weld the seam without the addition of filler or the use of flux. This resulted in a nearly flush joint that did not require cleaning and had excellent physical strength. The use of filler was eliminated by clamping both sides of the joint tightly within $1/4$ in. of the joint. Bringing the heat of the arc to the metal expanded it and forced it to hump at the joints. This hump was melted down, giving a flush weld. As the metal cooled, a little elongation occurred between the clamps but this was so slight that it had little effect upon the strength of the joint. In some cases where a fillet weld was necessary between sheet stock and a heavier section, the metal arc welding process was used to good advantage. Allowance had to be made for distortion wherever possible. When this allowance could not be made, however, it was possible to reduce the distortion by using proper fixtures and sequence. In some cases, welding sequence can be used to reduce distortion and machining sequence to correct it.

By careful planning of operations in manufacturing the Type I-40 engine, it was possible to solve these problems and to make parts according to the manufacturing drawings, in spite of the many problems encountered in welding on sheet metal. General Electric Company.

Heated-Intake Cowl Linings

Goodrich electrically heated rubber linings are being produced for the intake cowls of jet-propelled or jet-assisted airplanes. The rubber facings aid the cooling system by keeping ice away. The accumulation of ice on the jet cowls, which direct the flow of air from the plane's leading edge over the generator and other engine accessories, interferes with the airflow. These electrically heated linings also serve as anti-abrasion shoes. The B. F. Goodrich Company.

Square-Tipped Propeller Blades

A new type of propeller blade for transport aircraft—square-tipped instead of elliptical, and almost rectangular in shape—has been developed to meet the advances in airplane speed and engine power made during the recent war.

The new blade is the result of aerodynamic research designed to maintain high propeller efficiencies as airplane speeds approached the speed of sound. In his research, the propeller designer has been faced with three major problems: (1) efficient absorption of the much greater horsepowers required for high speed; (2) reduction of energy losses resulting from increased blade drag and propeller slipstream momentum; (3) minimizing the compressibility losses suffered by conventional propeller blades at high speeds, which brought their operating efficiencies to below acceptable requirements.

It is stated that extensive investigations have shown that the wide square-tipped blade is the best solution to all three problems, and that width added at the tip affords the maximum increase in blade power absorption with the minimum weight increase, thus permitting the design of lighter blades. The square tip, because it carries the airfoil section for the blade's entire length, makes it unnecessary to distort the airfoil design at the tip as was required with the round-tip blade. This contributes to superior blade performance. Further, it permits the use of a thinner, less cambered airfoil at the tip, resulting in substantial reduction of compressibility effects.

A source of concern at the beginning of the square-tip development program was the problem of noise levels. An intensive investigation has been conducted into this phase of operation and is continuing, with advance indications that noise levels will be no greater than those of the conventional propeller blade. In one installation checked, a slight reduction in noise has been noted.

It is stated that the earliest version of the modern square-tipped blade was first placed in use in 1945 on the North American P-51 Mustang and brought a material improvement in the aircraft's high-speed performance without sacrifices in any other phase of operations. Of duralumin construction, it was the forerunner of Hamilton Standard's new group of square-tipped blades and was more rounded at the leading and trailing edges of the tip than the 1946 models. The latter will be installed on such new commercial and military aircraft as the twin-engined Martin 202 and Consolidated Vultee 240. Hamilton Standard Propellers Division of United Aircraft Corporation.

Smaller Hydromatic Propellers for Medium-Sized Airplanes

A smaller version of the Hydromatic propeller has been placed in quantity production by Hamilton Standard Propellers Division of United Aircraft Corporation. The new model is designed to afford better performance for twin-engined aircraft in the feeder-line, private, and executive category.

The same quick-feathering characteristics and wide range of constant-speed operation that identified the larger Hydromatic types used on American military planes and air liners are available in the "junior" model. Generally suited for aircraft ranging in passenger capacity from four to 20, it is used primarily on engines of from 450 to 600 hp.

One of the first installations was the Beech Aircraft D-18, a twin-engined transport type now being produced in quantity for feeder lines and for private and executive-type operators. With one of its Hydromatic propellers feathered, it is reported that the D-18 climbed faster and higher than was possible with a "wind-milling" constant-speed propeller on an inoperative engine. The rate of climb was increased by 100 ft. per min. at both sea level and at 5,000 ft., while the absolute ceiling was raised by 2,400 ft. In addition, pilots flying with a feathered Hydromatic reported considerable improvement in the airplane's trim and handling characteristics over previous one-engine trials, while the drag coefficient of the airplane was reduced by as much as 12 per cent.

Ranging from 8 ft. 3 in. to 10 ft. in diameter, the small Hydromatic is virtually unchanged in design from the propellers as large as $16\frac{1}{2}$ ft. in diameter which equip present air liners. The

blades are of lightweight duraluminum alloy. Hamilton Standard Propellers Division of United Aircraft Corporation.

Plastic World Globe

A new plastic world globe, 52 in. in diameter and weighing only 70 lbs., is made by laminating fabric with cellulose acetate in solution. Fabric is placed on a form in the shape of a half globe and a solution of cellulose acetate is applied. This procedure is repeated with five or six layers of fabric. The layers of fabric are allowed to set and are removed from the form when thoroughly dry. The halves are then joined and sealed with a cellulose acetate solution. The map, the scale of which is 1 in. to 157 miles, is mounted on the globe and a protective coating of cellulose acetate is applied over it. It is stated that, because the globe is made of cellulose acetate laminate, it is extremely tough without being brittle, is durable, lightweight, and has low flammability. The plastic coating over the map has the same properties in addition to being resistant to discoloration by sunlight, weak organic acids, and organic solvents. It is possible to write on the globe, which can be easily cleaned with a damp cloth or soap and water. Hercules Powder Company, Wilmington, Del.

Synchronous Motor Welder

By utilizing the separate exciter of the Hobart electric-drive welder, a compact, high-performing synchronous motor welder has been produced. The unit is so proportioned that it can be started by direct connection across the line and will automatically synchronize itself by the build-up of the separate exciter. The starting current on this unit is approximately the same as a conventional induction motor of the same power capacity.

The motor is a Hobart revolving-field synchronous type. It is equipped with a heavy squirrel-cage winding to make starting as easy as in a conventional induction motor. Once up to speed, the exciter builds up and automatically applies correct excitation to the motor fields.

The machine can also be used as an a.c. generator for the operation of small tools, lathes, and grinders. This is done by coupling the shaft to a gasoline engine or electric motor. The Hobart Brothers Company, Troy, Ohio.

Pneumatic Impact Wrench

A new Thor pneumatic impact wrench, for driving and removing nuts, bolts, and cap screws up to $^3/_8$-in. thread size is announced. Unusually small and light in weight, it contains impact mechanism designed to provide full striking power of the tool over a long period when used for steady production, assembly, or maintenance operations.

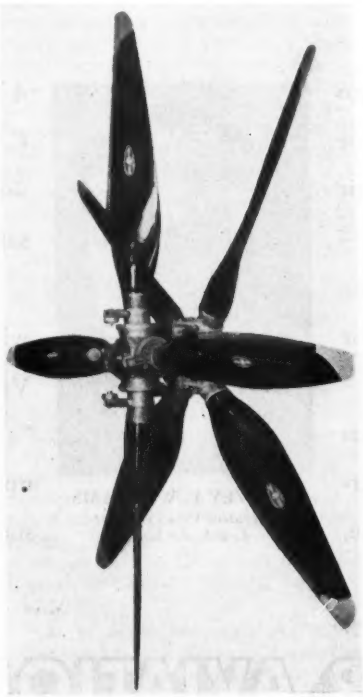
Rotatively striking impact jaws, set at a wide radius from the spindle center to reduce stress, and a short, rigid spindle shank that delivers the blow close to the work, are principles used in the impact mechanism. The elimination of fastenings in the mechanism and the compact, streamlined design of the housing reduce the weight of the tool to $3^3/_4$ lbs. and the length to $5^7/_8$ in. for comfortable, one-hand operation with reduced torque reaction. Independent Pneumatic Tool Company, Chicago.

Hatching Stencils

The introduction of Instrumaster hatching stencils is stated to make possible a marked reduction in the time required for crosshatching and to enable neater drawings to be produced. Precision markings enable the user to predetermine the exact location of the hatchings. The stencils are made from clear, nonwarping, noninflammable plastic stock. Aligning marks and lettering are indelibly debossed. Lines at 30°, 45°, and 60° to the horizontal can be drawn without a separate triangle. The stencil can also be used as a 75° triangle if desired. It is available in 5 by 6 in. and 6 by 8 in. sizes. Instrumaster Industries, Inc., Greenwich, Conn.

Gravity Conveyer

A new light-duty gravity conveyer contains several innovations that give it greater range in use and adaptation, including a special type of bearing. It is supplied with a choice of two types of quickly adjustable leg supports, single and double post, and in various lengths, capable of being quickly coupled into a continuous unit for conveying straightaway and around curves. Island Equipment Corporation, New York.



The experimental $11^1/_2$-ft. diameter eight-bladed, counterrotating propeller produced for the U.S. Navy by the Bartlett-Hayward Division of Koppers Company.

Electric Tachometer Generators

A compact electric tachometer generator weighing less than 23 oz. has been perfected. It is stated to permit more than 50 per cent saving of space and weight over many types of standard units now installed in aircraft. Easier maintenance, lower cost, and improved operational characteristics are advantages claimed for the unit, which is to be identified as the Kollsman Compak Generator.

The generator operates a three-phase electric tachometer indicator of either the standard sensitive or dual type, to provide a pilot with accurate indication of a plane's engine speed. It is designed for use where tachometer indication for each engine is required at only one station and, like standard generators, operates from tachometer outlets rotating at one-half engine speed. The output of the unit is sufficient to actuate both a tachometer instrument and a synchroscope instrument, and may be used with special Kollsman helicopter tachometers. Where duplicate engine instruments are required the generator may be operated at crankshaft speed, using a two-pole arrangement. The unit is then capable of actuating two tachometer indicators and, where desirable, a synchroscope. This adaptability feature is specially useful in connection with jet-engine applications. Kollsman Instrument Division of Square D Company.

Eight-Blade, Counterrotating Automatic Propeller

Details of an experimental $11^1/_2$-ft. diameter Aeromatic counterrotating, eight-bladed propeller produced for the Bureau of Aeronautics of the U.S. Navy have been disclosed by the Bartlett Hayward Division of the Koppers Company, Inc.

Designed for an airplane having a 2,500-hp. engine and a speed in excess of 400 m.p.h., the new propeller unit consists of two four-bladed propellers arranged in tandem and mounted on coaxial shafts to rotate in opposite directions. It operates on the same principle as the small Aeromatic light-plane propeller and governs the speed of one or two engines automatically through a wide range of air speeds and maneuvers. Only natural physical forces are utilized to change the blade angles, no electrical or hydraulic devices being employed for pitch changing. Metal blades are replaced with high-strength, plastic-bonded plywood covered with Aeroloid plastic sheeting. Use of this improved wood is reported to produce a blade of less than half the weight of a comparable metal blade.

The hubs used in the dual-rotating assembly consist of front and rear units, the rear unit being bored and splined to fit a No. 70 SAE spline shaft. The front unit is splined to fit a No. 50 shaft which extends through the hollow

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No. 70 spline shaft. Except for these differences in spline-shaft size, both front and rear hubs are identical. There is no translation member or any connecting link between the two hubs, and the rear hub is fitted with a housing that covers the thrust bearing between the two shafts. Since the hub was designed to contain four blades, it was bored straight through for each blade socket and bored through the center for the insertion of a spline sleeve. The spline sleeve is welded at the front and rear faces of the hub by the atomic hydrogen welding process. A face is machined on each side of the spline sleeve in the center of the blade socket to receive inner journal bearing bosses and a positive stop device.

To simplify the structure of the hub shell and provide a means of synchronizing the movement of all blades, a synchronizer boss is machined between each blade socket. Fitted with studs, the boss positions a small gear internally between the toothed flanges that retain the blades. Thus the movements of all blades are synchronized with one another. As in all Aeromatic models, the counterrotating unit employs a lag angle incorporated in the construction of the blade-retaining flange. Also, each flange is fitted with a counterweight bracket and weight to complete the motivating assembly. Because of the lag angle of the blades, thrust acts to turn the blades to low pitch at take-off and under conditions when thrust is high. Opposing this aerodynamic moment is the counterweight's centrifugal moment generated by the propeller's rotation, tending to rotate the blades to high pitch. At any given forward speed these values of centrifugal force and thrust will position the blades to the correct angle for aerodynamic efficiency and rotational speed. Any change in speed results in a corresponding pitch change attributable to the forces seeking equilibrium.

The blades are fabricated from $1/16$-in. laminations of maple, bonded under heat and pressure by a thermal-setting resin. To increase the stability of the blade blocks, these laminations are splayed alternately at 15° to the centerline. After fabrication by a profiling machine, the blades are chemically sealed in ferrules and the lag-screw method of blade retention is used to secure them. Transparent Aeroloid plastic sheeting is pressure-bonded to the exterior of the blades while pliable, and hardens to a tough resilient state that provides a maximum amount of protection for the wood structure. Stainless-steel leading-edge sheeting is applied over the plastic to give further protection to the leading edge from the effects of abrasion. Koppers Company, Inc., Bartlett Hayward Division, Baltimore.

Special Instrument Panel for Private Airplane

In designing an instrument panel for his personal Beechcraft Model 18, which he flies on his business trips, William P. Lear was guided by the opinions of veteran air-line, private, and military pilots concerning the grouping of the most important flight and navigation instruments. The desirability of a standard installation whereby the pilot would be familiar with the controls and instruments in any airplane was a governing factor and it was for this purpose that experienced pilots were asked for their advice.

In determining the best arrangement of the instrument panel, the pilots stressed certain basic groupings. Flight, navigation, and power-plant instruments should be located for convenient reading, and radio equipment should be placed in direct view, within easy reach for tuning. The new instrument panel is arranged so that radio equipment, flight, and navigation instruments are directly in front of the pilot, easily visible at all times.

The selection of radio equipment for this panel represents an optimum choice especially adaptable for the radio communication and navigation requirements during the interim period of the changeover of the airway facilities to operate on the Very High Frequencies. It includes the Lear three-band Model ARC-10 automatic radio compass that can be used for low-frequency, long-range radio navigation with the RCBB three-band receiver as an auxiliary unit. Provisions have been made for manual operation of the ARC-10 loop antenna in connection with the RCBB unit.

Among the features of the ARC equipment is the simple loop antenna that consists of a small loop of approximately 4 in. rotated by an "H"-drive mechanism. Instead of the usual large, heavy "tear drop," the streamlined new loop cover will be a transparent lightweight blister. Another feature is the servo unit with combination dynamotor, power supply, and gear attachment with clutch arrangement that will automatically rotate the loop to the usual null position when tuned to any particular station. It is expected that the total weight of this automatic equipment will be in the neighborhood of 20 lbs. There is also a five watt, five-frequency Lear V.H.F. transmitter, the companion unit to which will be the V.H.F. tuning unit for the receiver. The third component of this combination is a combined R.F. amplifier, second detector audio amplifier, modulator, and power supply.

Both of the tuner units will work into this power-supply equipment similar to that in the Lear radio T-30AB-RCBB Combination, long used for medium-frequency operation. Later, it will be possible to add the omnidirectional accessory for the azimuth indication of automatic bearings on omnidirectional ranges. This unit has a rotatable azimuth that can be set for any particular station, permitting "homing" with this equipment.

The engine instruments are on the right-hand side of the panel where they are visible when there is need for checking, but not interfering with the pilot's vision when he should be watching flight and navigation instruments. Lear Incorporated, Grand Rapids Mich.

Crankshaft Lathes

LeBlond 9L and 9P automatic crankshaft lathes have been developed and perfected during the late war. The two machines complement each other and together completely machine all bearings on aircraft-engine crankshafts.

Both machines are powered by a combination electric-hydraulic drive, from a 30/20-hp. a.c. main drive motor on the 9L, or 40/20 hp. on the 9P. They are entirely automatic and are controlled by a push-button station on the left-hand driving gear housing. The R. K. LeBlond Machine Tool Company, Cincinnati.

Flight-Engineer Trainer

A portable flight engineer's station that is stated to eliminate half the air-training time of flight engineers by instructing them on the ground has been developed by the training aids department of Lockheed Aircraft Service.

In addition to its primary use in pretraining of flight engineers, the portable station is useful for acquainting other members of the crew with the engineer's duties and in disclosing faulty techniques through periodic check flights.

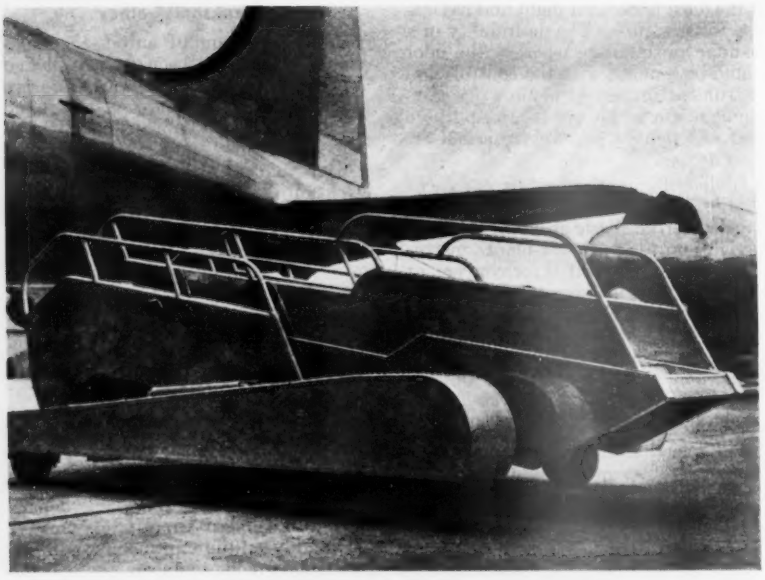
The training device duplicates normal and emergency functions of the flight engineer's station in the Lockheed Constellation transport. Lighting effects and a loudspeaker reproduce visual and auditory aspects of flight. By manipulating switches and dials on his control panel and by using the intercommunication system as a pilot and his crew do, the instructor tests student reaction to all phases of the job.

The device weighs 1,450 lbs. and is $81\frac{1}{2}$ in. high, 68 in. wide, 71 in. long. It operates on alternating current, 60 cycles, 120 volts. Lockheed Aircraft Corporation.

Passenger Ramp and Other Airport Equipment

One of a number of items of airport equipment developed by The Glenn L. Martin Company is a new adjustable passenger ramp that is designed for use with any airplane having an entrance door sill within the range of 86 to approximately 126 in. above the ground. Constructed entirely of aluminum alloy, the ramp is built in four major sections, comprising the truck, support, lower steps, and upper steps.

The step section consists of the lower area made up of ten treads with a depth of 11 in. and a 22-in. platform with 8-in. risers. The platform, located between the fifth and sixth steps, is "matched" at the top with a similar area which is $37\frac{1}{2}$ in. deep. This second platform is part of the upper section which also has four steps identical with those in the lower area. The total number of steps can be varied between eleven and 16, thus allowing one-step increments, while the riser height remains constant. When the ramp is in its lowest position, the top platform is 48 in. deep, as the tread of the top step of the lower section and the platform of the upper section are on the same level.



The Glenn L. Martin Company's adjustable passenger ramp.

The truck is mounted on two 16-in. fixed wheels and two 16-in. casters. Positive lock brakes are provided on both wheels and casters so there will be no possible chance of the ramp moving away from the side of the plane when passengers are boarding or alighting. It is so designed that the complete step assembly can be folded into an almost horizontal position, when the overall height will not exceed 6 ft. The ramp is 94 in. wide, is 205 in. long, and weighs approximately 850 lbs. Lights are provided for properly illuminating the steps and platform during night operations.

Circular-type passenger ramps also are being constructed by the Martin company. Several versions have been designed for use with the converted C-54 air liners, featuring the same construction.

All versions of the circular model have three step-landings incorporated in the design. Each step consists of an 11-in. tread and an approximately $8^1/_2$-in. metal riser. All three landings have a nonskid metal surface. Each features an offset in the handrail and skirt at the top platform which provides a recess for the airplane door when it is opened to a 90° angle. One version has a large top platform, 36 by 50 in., located 90 in. above the ground for use at the rear entrance door of the C-54 planes. Passengers may enter the lower platform from either side of this ramp. Another version features an adjustable top platform that can be used at heights of either 88 or 96 in. This adjustment compensates for the variation in the doorsill height under different loading conditions. A third version is designed for use at the forward entrance of the C-54 airplane, incorporating an additional, removable top-step auxiliary platform to the top platform of the ramp. The style of tread, platform, and risers on the auxiliary platform match the treads and risers of the ramp. With this platform in place, the top landing is raised from 90 to 106 in. above the ground.

Other ground handling equipment also being manufactured by the Martin company and available to air lines, are an adjustable cargo loader with a rubber-covered belt which carries cargo from a point near the ground to the airplane cargo compartment, and vice versa; a wheeled platform for loading the plane through the "belly" compartments; a nose-gear towing bar; a tail support device; propeller dollies; service ladders; outer wing slings; engine slings; protective wing and nacelle coverings, and several other items. The Glenn L. Martin Company.

Miniature Jet Propulsion Engines

The Minijet model jet propulsion engine—an improved scale version of the German "buzz-bomb" power unit—applicable to the operation of model airplanes, race cars, and speedboats, is designed to power scale models of the P-80, P-59, and other jet-propelled aircraft. The manufacturer states that its small frontal area and overall length of approximately 27 in. allow the modeler to build an aerodynamically clean airplane with high performance. It fulfills thrust requirements necessary for high-speed model plane flight. In experimental tests, the Minijet is reported to have driven a model race car at over 80 m.p.h. and a scale model of the B-24 at more than 110 m.p.h.

A small ignition unit incorporating a model "T" Ford type of coil, a six-volt "Hotshot" battery, and an ordinary tire pump, is sufficient to start the engine. No flight ignition is necessary, thus eliminating the coil, condenser, breaker points, and battery common to reciprocating-engine installations. The fuel tank is pressurized from the combustion chamber. After a few trial runs to find the proper needle-valve setting, the engine can be flown without further adjustment.

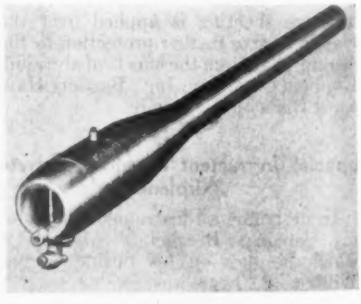
The Minijet is stated to have a smooth, steady take-off and acceleration which increases its adaptability for control-line speed flight and maneuvering. There is no danger of losing control of the model from torque turning the model in toward the operator on the take-off. The engine maintains a steady flow of power. It has four moving parts and weighs approximately 16 oz. Minijet Motors, Pasadena, Calif.

The XB-35 "Flying Wing" Bomber

The Northrop XB-35 is an all-metal, tailless, four-engined bombardment-type aircraft built on the "Flying Wing" design, with no tail surfaces and using "elevon" controls as both elevators and ailerons. It is of full-cantilever construction, with designed weight empty of 89,000 lbs., loaded weight 162,000 lbs., and overload gross weight of 209,000 lbs. Its span is 172 ft.; area, 4,000 sq.ft.; root chord, $37^1/_2$ ft.; and tip chord, 9 ft. 4 in. Overall height is 20 ft. 1 in.; overall length, 53 ft. 1 in.

Power is supplied by four Pratt & Whitney Wasp Major engines, two of which are the R-4360-17 and two of the R-4360-21 series, equipped with single-stage General Electric turbosuperchargers. Each engine has a normal rating of 2,500 hp., and military power of 3,000 hp. The four propellers are of the new Hamilton Standard Superhydromatic series—coaxial, reversing, counterrotating, and each having four blades. Propeller diameter is 15 ft. 4 in. Reverse pitch of the propellers can be used for braking. Details of the new propeller are still restricted. Landing gear is of the tricycle type, with dual wheels, 5 ft. 6 in. in diameter on the main gear, and a single wheel 4 ft. 8 in. in diameter on the nose gear. The landing gear is fully retractable.

Northrop-designed "elevons" performing the functions of elevators and ailerons are located on trailing edges of the wing. Span of each elevon is 34 ft. 6 in. Trim flaps and rudder assembly are at the wing tip. Landing flaps occupy the center section of the span. Slots in the wing tips aid in control at low speed. Controls are actuated through a full-boost hydraulic system, coordinated with special Nor-



The Minijet model jet propulsion engine.

throp-designed pneumatic loading devices to give the pilot the sense of "feel."

The Northrop Flying Wing XB-35 is built with a new aluminum alloy developed by the Aluminum Company of America. It carries gasoline in bullet-proof, leakproof tanks, and can carry additional gallons in tanks in its bomb bays and other wing compartments. The wing section itself is 37½ ft. long at the center, tapering to slightly more than 9 ft. at the tips. It sweeps back from center to tips, making the overall length of the craft slightly more than 53 ft.

Normal crew for the XB-35 is nine men: pilot, copilot, bombardier, navigator, engineer, radio operator, and three gunners. Cabin space is available for six men to alternate with crew members on long missions. Folding bunks accommodate the off-duty men. Although designed for a bomber, it could easily be adapted as a cargo liner. Northrop Aircraft, Inc.

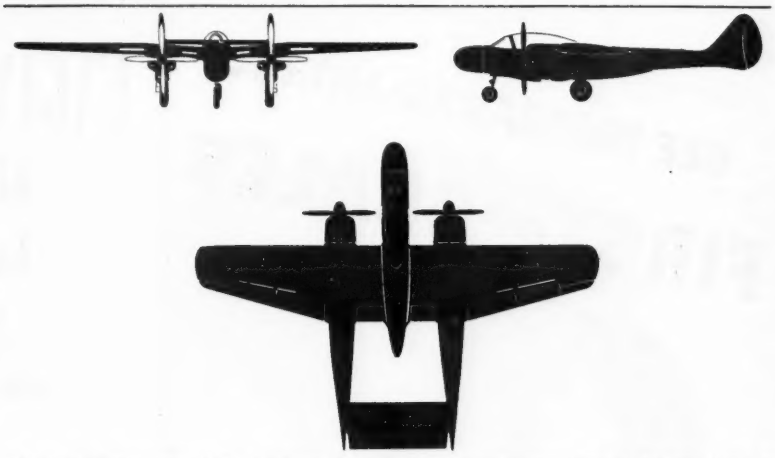
F-15 Reporter Photo-Reconnaissance Airplane

Military restrictions have been removed from information concerning the fast, long-range, photo-reconnaissance plane designated as the Northrop Reporter F-15. It is a two-place, twin-engined plane capable of long-range mapping and reconnaissance tasks formerly restricted to heavy, four-engined airplanes. It is a midwing monoplane, with twin booms connecting the tail surfaces to the engine nacelles. A long, slender crew nacelle seats the two crew members in tandem fashion, one behind the other. The Reporter can carry six cameras, in 24 optional arrangements which make possible the mounting of eleven different types of cameras. Cameras can be added in several combinations, pointing forward, straight down, and obliquely. The cameras can be operated in any combination by a remote-control button system. Either crew member can pilot the plane or operate the cameras. A long Plexiglas canopy covers the crew nacelle and slides back for easy access of both crew members. Both pilot and copilot are fully enclosed under the canopy.

The engines are Pratt & Whitney R-2800-C, developing 2,100-hp. for take-off or 2,800 hp. under emergency power. They are turbosupercharged and drive Curtiss Electric high-activity propellers measuring 12 ft. 8 in. in diameter and built with special wide blades. A 500-gal. internal gasoline tank is carried just aft of the copilot. With drop tanks, wing tanks, and the internal tank, the Reporter can carry enough fuel to sustain flight for more than 4,000 miles.

The plane carries a full set of flight controls for the copilot, and a set of engine and flight instruments for emergency operation from the rear seat. Northrop-designed retractable ailerons and full-span flaps add to the plane's flexibility and maneuverability. The ceiling is over 35,000 ft., and its speed, the Army has disclosed, is "more than 400 m.p.h." Its rate of climb is extremely fast.

The war's end, instead of eliminating the need for the Reporter, speeded its production. Military leaders visualize peacetime uses for this new aircraft, such as aerial mapping in soil-erosion control and for geological research. Northrop Aircraft, Inc.



Three-view silhouette of the Northrop Reporter F-15 photoreconnaissance airplane shows its clean lines.

Lightweight Thermal and Acoustical Insulation for Aircraft

Lightweight, noncombustible Fiberglas thermal and acoustical insulation material, developed during the war for use in military aircraft, is available for installation in civilian aircraft and other applications where light weight is of importance.

The material is identified as Fiberglas Superfine PF Insulation. It is composed of glass fibers, with an average diameter of 0.00005 in., which are treated with a thermosetting binder and shaped into resilient, flexible, ½-in.-thick sheets. Sheets are available in 48 and 54 in. widths. Density is 0.6 lb. per cu.ft. Approximate weight of the sheets per square foot is 0.025 lb. Length of a roll is 50 ft.

Thermal conductivity of the sheets is 0.26 B.t.u. per sq.ft., per hour, per in. of thickness, per degree Fahrenheit temperature difference, when measured at a density of 0.6 lb. per cu.ft., and at a mean temperature of 75°F. Heat capacity of the ½-in. thickness is 0.005 B.t.u. per sq.ft., based on the same nominal density and a specific heat of 0.20 B.t.u. per lb. Moisture absorption is less than one per cent by weight.

Electrical sound transmission tests have been conducted regularly for almost 2 years, employing two ½-in. layers of the Fiberglas material, with an asbestos septum between them, and faced on one side with trim cloth. Results of a representative test based upon a typical aircraft fabrication, and under specific conditions, show a merit factor of 186 and average attenuation of 71 db. Owens-Corning Fiberglas Corporation, Toledo, Ohio.

Postwar Super Cruiser PA-12

Resembling its prewar predecessor only in the basic lines of its wing and tail, the new Piper PA-12 Super Cruiser is a completely revised and restyled 1946 model. Its additional power has raised the cruising speed to 25 m.p.h. over that of the Piper J5. At a cruising speed of 100 m.p.h. the new craft has a range of 600 miles, or 6 hours' duration.

Power is supplied by a 100-hp. 4-cylinder Lycoming horizontally opposed engine, an increase of 25 hp. over that of the original Piper Cruiser produced in 1940. A full-pressure cowling encloses the engine. A major feature of the engine installation is the standard Delco-Remy starter and generator used in conjunction with a 12-volt battery. The two units are mounted on the forward section of the engine, providing greater accessibility for maintenance and removal than when in the rear. Power from the starter is transmitted to the crankshaft through a large gear forward of the crankcase. The gear ratio is 13½ to 1. The generator is operated by a belt drive.

The cabin interior and appointments have been completely revised. Sliding windows are used, providing wide openings for photography, etc. Plexiglas is used in all windows, including the one-piece windshield.

The instrument panel contains standard instruments including altimeter, compass, air-speed indicator, ammeter, tachometer, oil-pressure and temperature gages. A mixture control with idle cutoff also is provided. Provision has been made for installation of a standard radio transmitter and receiver in the center of the instrument panel. Lighting equipment includes navigation and instrument-panel lights. The starter button is located on the instrument panel. The parking brake lever is under the right side of the panel. Dual controls and hydraulic brakes are standard equipment, the controls in the rear seat being quickly removable when passengers are carried. Space for 41 lbs. of baggage is provided in the compartment behind the rear seat.

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Conventional construction is used throughout the Super Cruiser. Fuselage is welded steel truss structure, fabric covered. Wings are made up of metal ribs with extruded aluminum spars in place of spruce used before the war.

Fully loaded the airplane has a gross weight of 1,750 lbs., including 38 gal. of gasoline carried in the two wing tanks. Fuel consumption is 6½ gal. per hour. Other items in the specifications of the PA-12 are as follows: total wing area, 179.3 sq.ft.; landing speed, 48 m.p.h.; take-off run, 1,550 lbs. gross, 480 ft.; absolute ceiling, 1,550 lbs. gross, 17,800 ft. Piper Aircraft Corporation.

High-Powered Jet Engine

The latest member of the Rolls-Royce "River Class" of jet engines is the R.B.41, or "Nene" engine. The designed thrust is 5,000 lbs., which is reported to be greater than that of any other jet propulsion engine in current production. It opens a wider field of application for this new type of power unit which, up to the present time, has been used only to power interceptor fighters. Designed early in 1944 to conform to a design specification issued by the Ministry of Aircraft Production for an engine with a minimum thrust of 4,000 lbs., a weight not exceeding 2,200 lbs., and a maximum overall diameter of 55 in., the present production engines have a thrust of 5,000 lbs. and weigh only 1,550 lbs., representing an improvement of 25 per cent in thrust and 30 per cent in weight over the M.A.P. specification. These figures give a thrust of 3.2 lbs. per lb. of weight and, as the overall diameter is only 49½ in., a thrust of about 375 lbs. per sq.ft. of frontal area is achieved.

At a recent lecture to the Royal Society of Arts, some performance figures were predicted for a Lancaster powered by four Nene engines as an example of what could be done by using existing aircraft. It was stated that, for a total weight of 60,000 lbs., the cruising speed would be 400 m.p.h. at all altitudes up to 35,000 ft. and, using the existing fuel tankage, the range would be approximately 1,000 miles at 30,000 ft. The range would, of course, be increased by augmenting the fuel tankage. The four Nene engines would weigh only 8,000 lbs. when installed, compared with 12,000 lbs. for Merlin reciprocating engines.

The Rolls-Royce Nene is a pure jet propulsion engine with a single-stage, double-entry, centrifugal compressor delivering air into nine straight-flow combustion chambers. Once started, combustion and the operation of the engine are continuous processes, no electric ignition system being necessary except for starting purposes. The engine is throttled by regulating the supply of fuel to the combustion chambers.

The turbine wheel comprises a solid steel disc with 54 blades made of Nymonic 80 steel specially developed to prevent creep at high temperatures and to resist corrosion. The roots of the blades are broached to form tapered serrations that mate with similar broachings on the periphery of the turbine disc. This method of blade attachment permits axial and circumferential movement. At the center of the turbine disc an integral flange, serrated at its circumference, is provided for coupling the turbine wheel to corresponding serrations on the flange of the turbine shaft. The turbine wheel and shaft are secured by bolts that pass through the respective flanges. The object of the serrated coupling is to relieve sheer stress on the securing bolts at the higher engine speeds.

The rotor assembly, consisting of the impeller, turbine, and shafts, is supported in three bearings. The end bearings are of the roller type and the center one is a deep grooved ball bearing to take the shaft thrust loads. Just aft of the center bearing a spherical coupling transmits the axial thrust to the rear impeller shaft and thus to the center bearing which transmits the torque. The axial thrust is forwards up to approximately 8,000 r.p.m. and rearwards above this figure. Also mounted on the shaft between the compressor and the center bearing is a fan that directs cooling air on to and under the center and rear bearings and the face of the turbine disc.

The double-sided impeller has 29 vanes per side with separate forged aluminum rotating guide vanes machined all over. Each component of the rotor assembly is checked individually for alignment and balance and then finally aligned and dynamically balanced as a complete assembly.

The combustion chambers, equally spaced around the engine, converge into the discharge nozzle. They are of the straight-flow type. Each chamber consists of an outer casing, a perforated flame tube, and a duplex burner. The flame tube is fitted concentrically in the casing and the burner discharges into the flame tube. The combustion chambers converge on the discharge nozzle boxes, each chamber locating freely within its respective box to permit differential expansion. A slight taper inside the nozzle boxes ensures a gastight joint when the engine warms up.

A flame igniter is used, consisting of a small atomizer embodied in one unit with an igniter plug. The atomizer is fed with fuel from the low-pressure side of the fuel system, and is controlled by a solenoid-operated valve, which draws its current from the low-tension side of the ignition system. On starting the solenoid is energized at the same time as the igniter plug, allowing fuel to pass to the atomizer and to be discharged in the form of an easily ignitable spray. The high-tension spark from the igniter plug lights the spray, the flame of which in turn lights the spray of fuel from the pilot atomizer of the duplex burner. An automatic "time" control cuts out the ignition system and the solenoid-operated valve is closed by a light spring that cuts off the fuel supply to the igniter plug; by this time the engine is running under conditions of continuous combustion. Flame for lighting the other combustion chambers spreads through interconnecting pipes between the chambers.

The wheelcase at the front of the engine is driven from the forward impeller shaft; it houses drives for the aircraft accessory gearbox, the tachometer generator, and the twin fuel pumps; the starter motor is mounted on the port side. Wet-sump lubrication is used on the Nene as distinct from previous Rolls-Royce practice of dry sump with separate oil tank. The main supply of oil is contained in a sump formed by the lower part of the wheelcase. This sump houses the pressure and scavenger oil pumps, two gauze scavenger oil filters, the Purolator high-pressure filter, the pressure relief valve and a deaerator. The pressure pumps draw oil from the sump through the strainer and then to the high pressure filter. From the high-pressure filter oil is passed to the wheelcase to feed the bearings of the rotor shaft. Oil jets are arranged at critical points to operate in conjunction with restrictors and so supply a controlled quantity of oil to the bearings.

The exhaust system at the rear of the engine consists of the exhaust cone, jet pipe, and nozzle. These parts are mainly double-walled, with the space between the walls packed with heat-insulating material. The exhaust cone is the length of pipe immediately behind the turbine and is of fixed length, while the jet pipe that extends from the exhaust cone to the propelling nozzle varies in length according to installation requirements in the aircraft. In the center of the exhaust cone is a conical fairing with its base masking the turbine disc and supported by four long transverse bolts covered by streamlined fairings. The propelling nozzle is attached to the rear end of the jet-pipe and forms the aperture from which the gases exhaust to atmosphere.

Although production engines are rated at 5,000 lbs. thrust, development of the Nene engine is only in the early stages. It is expected that the eventual rating will be much greater. The highest thrust figure so far recorded on the test beds is 5,500 lbs., while on development work the average thrust obtained is 5,150 lbs., and this thrust has been used to measure the efficiency of the engine cycle. Rolls-Royce, Limited.

Tool-Grinding Fixture

An all-purpose tool-grinding fixture for the precision grinding of lathe tools, screw-machine form tools, shaper, planer, milling-machine, or any angle-cutting tools has been developed. The fixture operates on a patented principle involving the use of compound angles. It is placed on the magnetic chuck of a surface grinder and firmly held in place by the magnetic power of the chuck, thus eliminating the uncertainties of hand grinding. It is graduated by degrees up to 90, and angles both left and right may be readily obtained. The rake angle is ground on the tool at the same time by means of a tipping block, which gives 3°, 5°, 7°, and 10°

clearance. The principle involved employs four surfaces of the tilting block, so that when the 3°angle is desired the block is merely tipped to the 3° mark, after which it automatically lines up with the 3° angle surface on the main casting. The 5°, 7°, and 10° clearance angles are obtainable in like manner.

The fixture may be used to grind tools from 1/8 in. to 1 1/4 in., and is used for carbon, alloy, and tungsten carbide tool bits. Both inside and outside threading and recess tools may be ground on the fixture, and form tools may also be ground to provide the different cutting edges for various types of materials. George Scherr Company, New York.

Hinge-Panel Fastener

The Shakeproof Q-Two light-duty quick-operating fastener, designed for use on removable and hinged panels wherever accessibility for inspection, oiling, adjusting, cleaning, or servicing is required, consists of three parts; a stud that is held onto the outer sheet by a special spring washer and a receptacle that is easily snapped onto dimpled inner sheets or frames. Other features include allowance for variations in sheet alignment up to 1/8 in., compensation for variations in sheet thicknesses, elimination of rivets and screws, and positive locking with one-quarter turn. Shakeproof, Inc., Chicago.

New 20-In. Drilling Machine

Features of a new 20-in. drilling machine, designed for drilling up to 1 1/4 in. in cast iron or the equivalent in other metals, include wide interchangeability, with all parts tooled for accuracy of fit.

Forged steel is used in the spindles. Spindle quills are supplied with bronze oil-grooved bushings, and the Morse Taper is bored in the spindle after assembly is complete. Heavy-duty ball thrust bearings are provided. The manufacturers state that by boring the table arm, after assembly, with the machine's own spindle, table alignment is assured. The table is held at a right angle to the spindle with a tolerance of seven ten-thousandths in 6 in. High-tensile, semisteel castings in the new machine are made in the manufacturer's own foundries by controlled production methods.

The machined part of the main column is 5 1/4 in. in diameter. The drill table rotates on an arm that swings on the column to provide maximum working space. Both power and hand feed are supplied. Adjustment is provided for wear between worm and worm gear. The V-belt for the motor drive is adjustable by means of a hinged motor-mounting plate. Where it is necessary to operate the machine from a line shaft, it is provided with tight- and loose-pulley drive. A rotary geared coolant pump and geared tapping attachment also are available. Sibley Machine and Foundry Corporation, South Bend, Ind.

Spherical Roller Thrust Bearing

Technically known as the spherical roller thrust bearing, a new type of roller bearing capable of carrying heavier loads at higher speeds and lower temperatures is the result of a 10-year research program to solve the difficult problem of combining in a single bearing the triple features of high load capacity, speed, and low temperature.

The new-type bearing is expected to facilitate wind-tunnel operation for research into such aeronautical projects as gas turbine and jet propulsion speeds and designs. The self-aligning principle, which compensates for any shaft deflections, distortions, or weaves, permits heavy loads to be distributed evenly over all rollers and eliminates danger of overloading. Because of its compactness, it utilizes less space and is lighter in weight than a plain bearing, according to the manufacturer. Other features of the new bearing include more effective lubrication, and a cage-retaining sleeve pressed into the bore of the inner ring, making a contained assembly of the rollers, cage, and inner ring. SKF Industries, Inc., Philadelphia.

Flexible-Shaft Grinder

The Leigh VB-2 is a compact, convenient flexible-shaft machine that has the speed and power to operate small grinding wheels efficiently. It is featured by a cool-running, flexible, high-speed shaft, an improved-type ball-bearing spindle, and a special high-torque motor that delivers the smooth, even flow of power necessary for accurate light hand grinding, burring, and trimming of brass and die castings; filing, finishing, and polishing; breaking corners, etc. It is designed for both bench and suspended use.

The special spindle accommodates all mounted points and wheels with 1/4-in. or 1/8-in. shanks, as a No. 168A 1/4-in. to 1/8-in. reducing collet is included as standard equipment. This gives a range of tools from small mounted points to 1-in. diameter wheels. The motor is a 1/4-hp., a.c.-d.c. type, provided with an end ring for suspension and rubber-footed base for bench use. A variable-speed rheostat or line switch can be supplied. Many special arbors, mounted wheels, rotary files, rubber drums, polishing chucks, etc., are available as accessories. Spring Specialty Company, Maywood, Ill.

Small Dial Bore Gage

The Standard #0 dial bore gage extends the range of this type of instrument down to 3/8 in. Seven sizes are now available, to serve a range of 12 1/8 in. down to 3/8 in. Previously, the smallest such tool was for 5/8 in. work.

The #0 gage employs the same fundamental positioning principle used in the larger sizes. Two centralizing plungers, which act together, assure that the line of measurement passes through the center of the bore at all times. The gage is operated by inserting and rocking it, and noting the greatest deflection of the indicating hand.

The overall range of this gage, as well as that of the other sizes, is achieved by a series of diameter extensions that screw into the head opposite the actuating plunger. The gage is set by either a master ring or gage blocks. It is furnished with an indicator graduated in either 0.0001 in. or 0.002 mm. Standard Gage Company, Poughkeepsie, N.Y.

New Microwave Tubes

An entirely new group of Sylvania microwave tubes, evolved through a new set of design principles, and applicable to a wide range of additional uses in the industrial, electronic, communication, and navigation fields is being produced. The tubes, which are physically smaller than standard radio tubes, include receiving and low-power transmitting types for use at frequencies between 1,000 and 5,000 megacycles. These low-power types, because of their new basic design features, may be used with relatively simple wave-guide systems, and may be built into industrial production lines for various inspection, control, and grading operations.

It is stated that the microwave system might be arranged to accommodate the passage of many quantity-produced products directly through the microwave circuit to indicate faults of structure, composition, degree of moisture content, impurities, and surface hardness. Sylvania Electric Products, Inc., Advanced Development Laboratories, New York.

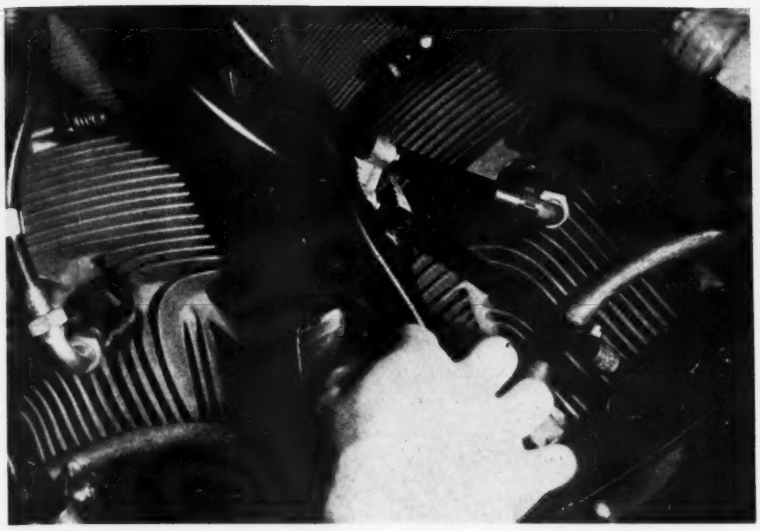
Ignition Conduit Clips

Quick-service clips for use on two parallel aircraft-ignition conduits have been developed. Designed as mating parts, assembly is accomplished by sliding two clips together and clamping with a pair of pliers. Disassembly is accomplished through a twist movement of the pliers or a screw driver. It is stated that the time of assembly and disassembly is 50 to 70 per cent less with the new clips than with conventional screw and nut types. Titeflex, Inc., Newark, N.J.

Method of Reducing Pilots' Eye Fatigue

As the result of a suggestion for reducing pilots' eye fatigue by the use of a filtered red light in the cockpit, the flight decks of United Air Lines' four-engined Mainliner 230's and 300's are being equipped with seven red filtered lights, three above the windshield and four above the instrument panel.

The red is designed to eliminate glare, filtering the light in such a way that it is possible for the pilot to glance from his instruments to the outside without waiting for his eyes to adjust themselves, thereby improving his ability to see well at night. It is stated that studies have proved that the dilation and contraction of the eye pupils, which occurs when ordinary white lights are used, produces a strain as well as momentary blindness. United Air Lines, Inc.



New Titeflex ignition-conduit clips are easily assembled by sliding together and clamping.

Built-In Coupling for Flexible Tubing

A simple coupling that is stated to make possible a "10-second" joining and disconnecting of individual sections of flexible tubing has been developed for Spiratube noncollapsible, retractable tubing.

The coupling is built into the tubing, thus eliminating the need for fittings. The couplings consist of a flat spring-steel collar that may be compressed to slip inside the end of another section and then released to form a strong, tight joint. The sections are easily disconnected by compressing the inner spring-steel collar and withdrawing the male end.

The couplings, like the rest of the tubing, are covered with long-fiber duck fabric, which has been processed to be fire-resistant and coated with a durable thermoplastic. There is no exposed metal inside or out, which makes the tubing safe in the presence of explosive or inflammable materials. The Warner Brothers Company, Bridgeport, Conn.

Temperature Regulator

A new mercury temperature regulator with signal light, either red or white, which glows brilliantly while the temperature is rising and shuts off when the setting temperature is reached, has been developed. The signal light can be seen at a distance when glowing, thus permitting the operator to perform other duties since he can determine at a glance when the temperature in the bath, oven, etc., has reached setting temperature and when the regulator is operating properly.

Called the Mercuroplat Thermoregulator, the device is intended for the accurate control of temperatures in water, oil, or air baths, ovens, etc., at any temperature within the setting range from −30° to 500°F. It is stated to have a sensitivity of ±0.02°F. or better.

It is available in 6-, 8-, 10-, or 12-in. lengths, has a machined plastic head designed to provide full visibility for easy setting, a convenient means for mounting, and an appropriate mounting for the signal light. Contributing to this temperature regulator's accuracy and length of life is an improved distilling and filling method by which the mercury is distilled directly into the regulator without being exposed at any time to atmospheric air, thus providing higher purity of mercury. Washington Glass Laboratory and Instrument Company, Washington, D.C.

Multiple Electronic Control Unit

A new development of the Wheelco electronic-control principle—the Multronic Capacitrol—adds further flexibility to meet applications requiring instantaneous, accurate indication and control of temperature, voltage, current, signaling, and similar variables in process industries. The new equipment provides (1) conventional on-off control at one or two different points; (2) control of two separate fuel systems on a single pot or other heat-treating type furnace; (3) automatic positioning control for electric, oil, and gas-fired equipment; (4) on-off control plus automatic fuel shut-off; or (5) multi-signaling at two points or two signals at dual points.

Two electronic-control circuits, without mechanical contact, operate in harmony with each other, but independently, to control the variables as measured by an accurate indicator featuring an alnico magnet, providing instantaneous control action. Wheelco Instruments Company, Chicago.

Radio-Controlled Azon Bomb

One of the war's most interesting weapons in the guided-missile category, the Azon bomb, was used extensively both in Italy and in the China-Burma-India theater. Controllable in azimuth only, the bomb is dropped from a plane in the conventional way. A red flare lights automatically, indicating the course of the bomb as it falls. The bombardier, using a special radio transmitter in the plane, can then watch and correct the progress of the falling bomb by radio as it approaches the target. Thus, if the bomb is seen to be heading toward a point, such as 500 ft. to the left or right of its target, the bombardier can radio the proper correction to the bomb, which then automatically deflects it to the required lateral distance and direction for a solid hit on the target. This directional control is effective within a 1,200-ft. range to right or left of the target. A later development, called the Razon bomb, can also be corrected to prevent overshooting or undershooting.

The bombs are equipped with radio-operated tail sections, the rudders of which are split and hinged. A miniature radio receiver in the tail of each bomb is activated by a radio transmitter in the "mother" plane, which controls the bomb rudders and alters the course of the bomb's trajectory within prescribed limits as desired by the bombardier.

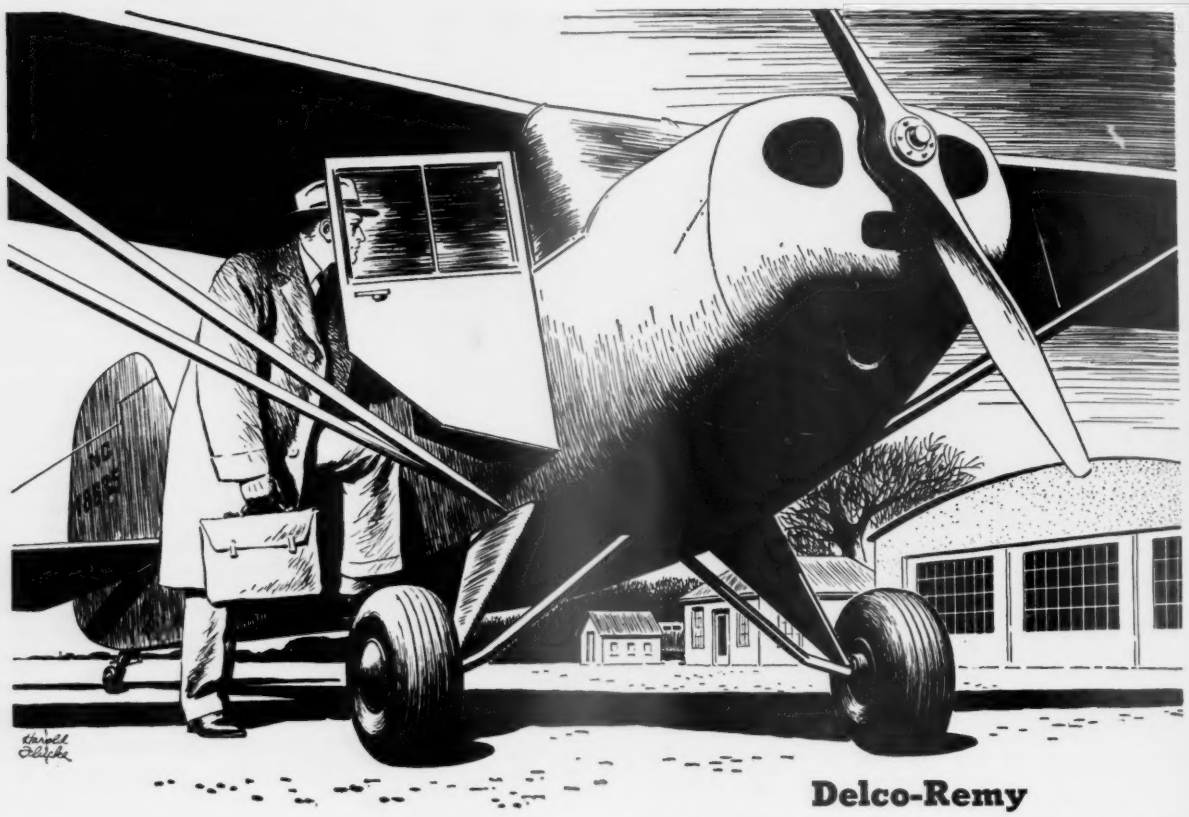
The bomb's power supply is a 6-volt, 9-plate, nonspill plastic-container storage battery weighing only $1\frac{5}{8}$ lbs. Willard Storage Battery Company, Cleveland.

New 800-H.P. Cyclone Engine

The new 800-hp. Wright Cyclone 7, selected by the Boeing Aircraft Company to power its forthcoming Model 417 twin-engined medium transport planes, was designed especially for intercity and feeder-line planes. The engine embodies all the latest features in engine building, including those developed during the war, and brings to a medium-sized power plant the same engineering experience that made possible the endurance of Wright engines developing 2,500 hp. in military bombers and transports. Many of the parts in the new Cyclone are interchangeable with the 1,425-hp. Cyclone 9 that is used in larger aircraft.

Characteristics of the small Cyclone are intended to meet the requirements of a medium transport capable of operating in and out of small airports. The engine, which performs well at the low altitudes reached in intercity flying, is stated to be inexpensive to operate and is easy and economical to maintain. Incorporated in it are such features as the forged cylinder head, aluminum fins for improved cylinder-barrel cooling, and a valve-gear lubricating system that substantially reduces maintenance and overhaul costs. Wright Aeronautical Corporation.

The Warner Brothers Company's built-in coupling for sectional flexible tubing.



Delco-Remy
Aircraft Electrical Equipment

Where is the man who spins the prop?

With the availability of Delco-Remy electrical equipment on popular makes of light planes, the delay and inconvenience of finding someone to spin the prop are things of the past. Sure, safe electric starting is now within arm's reach as you sit in the pilot's seat, ready to crank your engine and send you on your way. Lightweight, compact and thoroughly dependable, Delco-Remy electrical equipment brings new convenience at take-off, insures ample generator current during flight to recharge the battery and operate lights, radio and accessories.

☆ ☆ ☆

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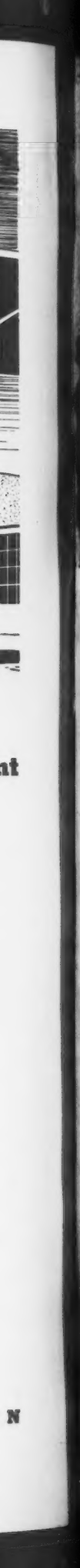
WHEREVER WHEELS TURN OR PROPELLERS SPIN